CHEMICAL ENGINEERING

July 10, 196

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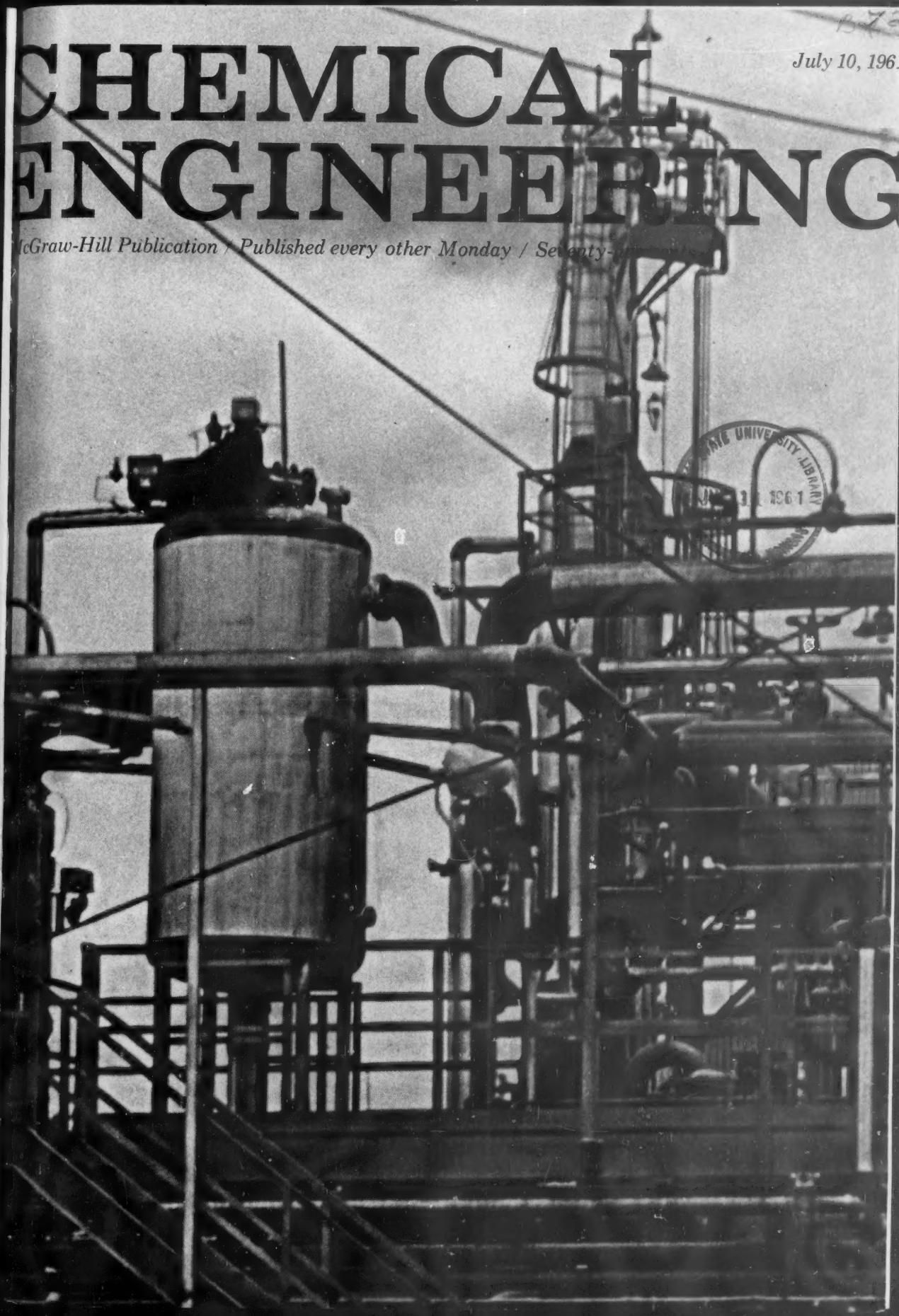

ROTARY OR CENTRIFUGAL

...Which one is best for your application?

Rotary or centrifugal? Sometimes the choice is easy. For example, you would use a rotary pump for very viscous liquids (over 2500 s.s.u.). Or where poor suction conditions exist. Or when positive displacement is required. Centrifugal pumps would be used for extremely corrosive or abrasive liquids, low viscosity liquids (under 2500 s.s.u.) water, slurries, or petroleum products.

But . . . in many applications combinations of these factors exist. Or the liquid you want to pump is not clearly in either area. Then there are other considerations such as initial cost, operating cost, lubrication value of the liquid, location and even budget limitations.

All of these considerations can put you in the middle—where either a rotary or centrifugal can be used. The best choice can only be made by someone with experience and knowledge of both types.

As one of the few manufacturers of a complete line of both rotary and centrifugal pumps, Worthington can help you select the best, most economical solution to this perennial pump problem. For the name and address of your nearest Worthington representative, consult the yellow pages.

P.S. If you'd like a copy of a 50-page booklet, "Rotary and Centrifugal Pumps: Theory and Design," please write to Worthington Corporation, Section 20-14, Harrison, New Jersey, for bulletin G-2666.

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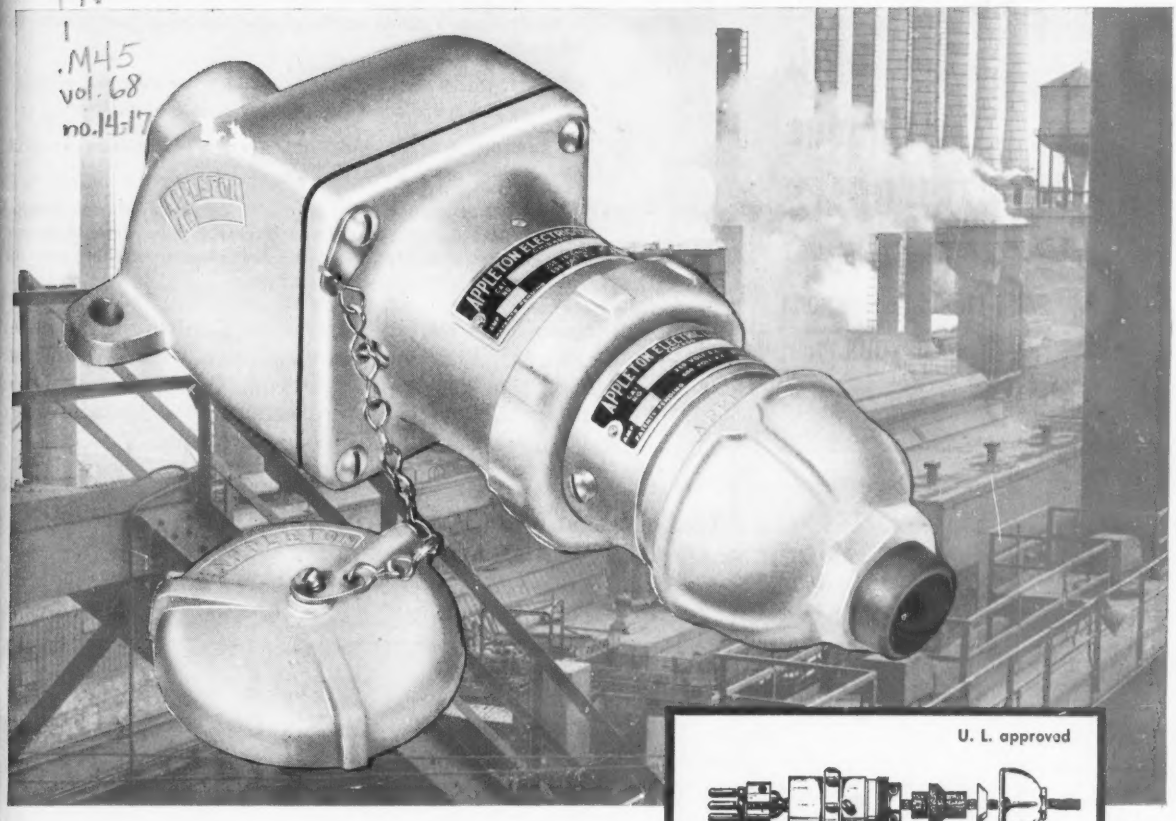

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CHEMICAL ENGINEERING

July 10, 1961

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

COVER PHOTO: Recently expanded Lawrence, Kan., plant of Cooperative Farm Chemicals Assn. typifies urea's booming growth as a fertilizer. For a look at the streamlined complete-recycle process used at Lawrence, see p. 116.

OTHER REGULAR FEATURES

PRINT ORDER FOR THIS ISSUE: 53,187

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highlights of this issue

GUIDE TO ELECTRICAL SAFETY

If you work in a plant that processes combustible liquids, vapors or dusts—and most chemical plants do—this 16-page Feature Report (p. 123) is "must" reading for you. It will show you how to provide safe conditions when using electrical equipment in hazardous areas. Author is Richard W. Scott of Crouse-Hinds Co., national chairman of the Chemical Industry Committee of AIEE.

REINFORCED PLASTICS FOR CORROSIVE SERVICE

Here's another guide, this one to selection of plastic materials for process equipment (p. 168). Even though you can't specify a particular material without actual field-test data, this Corrosion Forum article will start you in the right direction. It completes a two-part series begun in our June 26 issue, written by R. M. Webster, veteran engineer at Du Pont's Chambers Works.

CONTINUOUS ADSORPTION BRIGHTENS SUGAR

First new cane-sugar refinery to be built in the U. S. in more than 25 years shows what chemical engineering techniques can do to streamline operations and minimize costs in an age-old process. Here is Associate Editor Art Gemmill's report (p. 64) on American Sugar's new facility in Boston. Process highlight is a continuous moving-bed decolorizer; plant design features centralized control, complete with graphic panels and automatic data-logging.

For a message from the publisher.....SEE PAGE 7

Liquid vs. Solid Rocket Fuels

Sir:

Dr. Hendel is to be congratulated for his timely and detailed article, "Chemical Rocket-Propulsion Systems" (Mar. 6, pp. 99-114), covering the many facets of our industry.

The reader should not infer, however, that Dr. Hendel represents Aerojet-General's corporate position— any more than I do—but speaks only for himself. Let us refute his statements on "Liquid vs. Solid" (pp. 110-1):

• *Simplicity*—Modern solid-rocket motors have many more moving parts than "two to four."

• *Compactness*—The density-impulse of our interhalogen oxidizers with the newer slurried-metal fuels equals, and in some cases surpasses, that of the newest operational solid propellants.

• *Reliability*—The reliability of thousands of tiny JATO bottles should not be used to disguise the operational record of our ballistic-missile solid-rocket motors. And fewer parts is not synonymous with reliability; consider what happens to the reliability of a bolt and nut when we add a third component, the lock washer.

• *Safety*—With the storable liquid propellants used in our "third-generation" missiles, such as Titan II, there can be no explosion in case of battle damage to tankage, only a hypergolic fire. Whereas storable liquid propellants are insensitive to shock, many solid propellants will detonate when shocked, or break the bond between case and wall, or fracture the grain. Corrosiveness with storable liquids is not a problem when using proper materials of construction, and there are classified techniques which can be used to minimize toxicity.

• *Cost*—For the past few years, development costs for those liquid engines designed to perform tasks similar to solid motors for similar missions have been competitive. Liquid engine developmental costs become relatively even lower as thrust level increases and number of firings required to qualify the engine increases; this is due to the reusability for many firings of any liquid-rocket engine. In only very rare instances are solid-rocket motor casings salvageable, and then there are high labor and equipment costs for reloading.

Dr. Hendel's Table IV, comparing solids vs. liquids with the same specific impulse, is hardly an objective comparison. One would never select liquid propellants with the same specific impulse as solids for a comparable mission—not when all the immediately available liquid propellants have I_s values 10 to 50 sec. higher than today's competitive solids!

CHARLES A. O'MALLEY
Aerojet-General Corp.
Sacramento, Calif.

▶ *Mr. O'Malley's letter also included a number of specific comments relative to Dr. Hendel's Table V that are omitted here for lack of space. As we see it, the controversy between liquids and solids will continue to rage as long as capable chemical engineers continue to come up with new technological developments in each of the two areas.*—ED.

More on Control of Dryers

Sir:

Mr. Kinney's article on control of dryers (May 1, pp. 79-82) is competently written from the viewpoint of the control engineer, but it does not pay enough attention to the drying process itself.

Taking the nature of the drying process into account introduces factors of which a control engineer might not be fully aware. For example, Mr. Kinney says, "Exhaust air humidity is measured with a wet-bulb psychrometer." This is all right if you need to know the value of the humidity. But if you want a control signal, it is usually unnecessarily complicated; during the constant-rate evaporation period the wet-bulb temperature is substantially constant, and the dry-bulb temperature drops to a lower temperature depending on the heat load. Thus a direct measure of the exhaust dry-bulb temperature can be a better control signal than humidity.

Letters: Pro & Con continued on page 204

CE mourns death of veteran District Manager

Edward M. Schellenger, senior member of Chemical Engineering's business staff, died suddenly of a heart attack this spring at the age of 63. He had served as our Philadelphia District Manager since 1943, contributing in an outstanding way to the growth and success of CE.

By his willing acceptance of responsibilities, Ed continually improved CE's service to the chemical process industries and the chemical engineering profession. Always alert to the needs of suppliers advertising in Chemical Engineering, Ed helped solve many tough marketing problems by providing technical information and guidance. He richly deserved the compliments and gratitude expressed over the years by these suppliers and, particularly, the many communications of praise received since his death.

The entire staff of Chemical Engineering pays grateful tribute to a valued associate and wonderful gentleman.

Designed to Serve

The new treatment of our publication's name on the front cover and contents pages of this issue is not a change just for the sake of change. Our new logotype, we feel, will better project the identity and character of our magazine; and, through the qualities of the type face chosen, will imply those attributes of strength, authority and leadership that we on CE strive to attain.

Latest in a continuing program of modernization and innovation, this new logotype will also give us an opportunity to create more interesting and informative front covers.

In this course of product improvement, one thing has not been—and will not be—tampered with, and that is the basic purpose and character of CHEMICAL ENGINEERING. We shall continue to report and interpret the many factors affecting profitable application of technology to those concerned with chemical operations. And we shall endeavor to do this with the technical competence, diligence and awareness of industry conditions that you have a right to expect from a professional publication.

While our purpose and character are unchanged, we shall strive for improvements in our approach to this purpose. Our new logo is only the latest in a series of recent changes—all aimed at increasing our value to you:

- Publishing frequency accelerated to biweekly, starting in 1958, to broaden both functional and industry base.
- Editorial content increased in quantity and scope, plus more use of color to improve presentation.
- Adhesive binding substituted for staples, thus achieving two advantages—magazine opens flat and pages can be easily removed for study or filing. In a parallel move, complete fileability instituted so that every article and department can be removed and filed separately.
- *Chementator* schedule shortened by six days to increase its timeliness in coverage of the most significant news.

These and other changes have been based on our research into your interests and needs. Your comments and opinions have encouraged us to add new departments of real value, to prune those in marginal areas, to continually seek other ways in which we can achieve greater effectiveness in serving the chemical engineering profession.—J. ELTON TUOHIG, *Publisher*

CYANAMID

Chemical Newsfront

ONE CYLINDER, TEN OR A TANK CAR? Name your need for the CN ion, and Cyanamid's Hydrogen Cyanide (HCN) can fill it in any quantity—and economically, too. Compared with the considerably higher cost of solid cyanides, HCN—with better than 98% of its weight consisting of the CN ion—will save you money and may well repay investment in bulk handling and storage facilities, too. (Process Chemicals Department)

ELECTROLUMINESCENCE: TOMORROW'S LIGHT. The newest word for light is Cyanamid's CYANOCEL* chemically modified cellulose. A cyanoethylated, highly refined cellulose, CYANOCEL is the most efficient dielectric carrier for the filling in the "light sandwich" that makes possible lights without heat, glare or moving parts. In the future, it may be fabricated into walls, ceilings and even curtains to give a cool, uniform light. The picture above shows miniature furniture set up before 10 x 14″ GE panel lamps.

*Trademark

(Petrochemicals Department)

UNLOCKING POLYMER INSOLUBILITY. Thanks to copolymerization with Cyanamid's N-t-Butylacrylamide (t-BAM), vinyl monomers (whose polymers are ordinarily incompatible with alcohol) can produce polymers which are alcohol soluble. Such resins containing t-BAM can be applied from alcohol solutions—even in spray-can formulations. t-BAM is available commercially as a free-flowing wet cake or as a dry powder. (Market Development Department)

WHITE BUTYL RUBBER—THANKS TO PRONAR. Cyanamid's new PRONAR* butyl rubber modifier is a highly-active, non-discoloring, low-cost modifier that makes possible the heat treatment of white and light-colored butyl. Possible applications: in white side walls, housewares, wire and cable. For the full PRONAR story, send for Cyanamid's booklet by checking the appropriate area on the coupon.

(Rubber Chemicals Department)

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Oval "overcoat" for a problem pipeline

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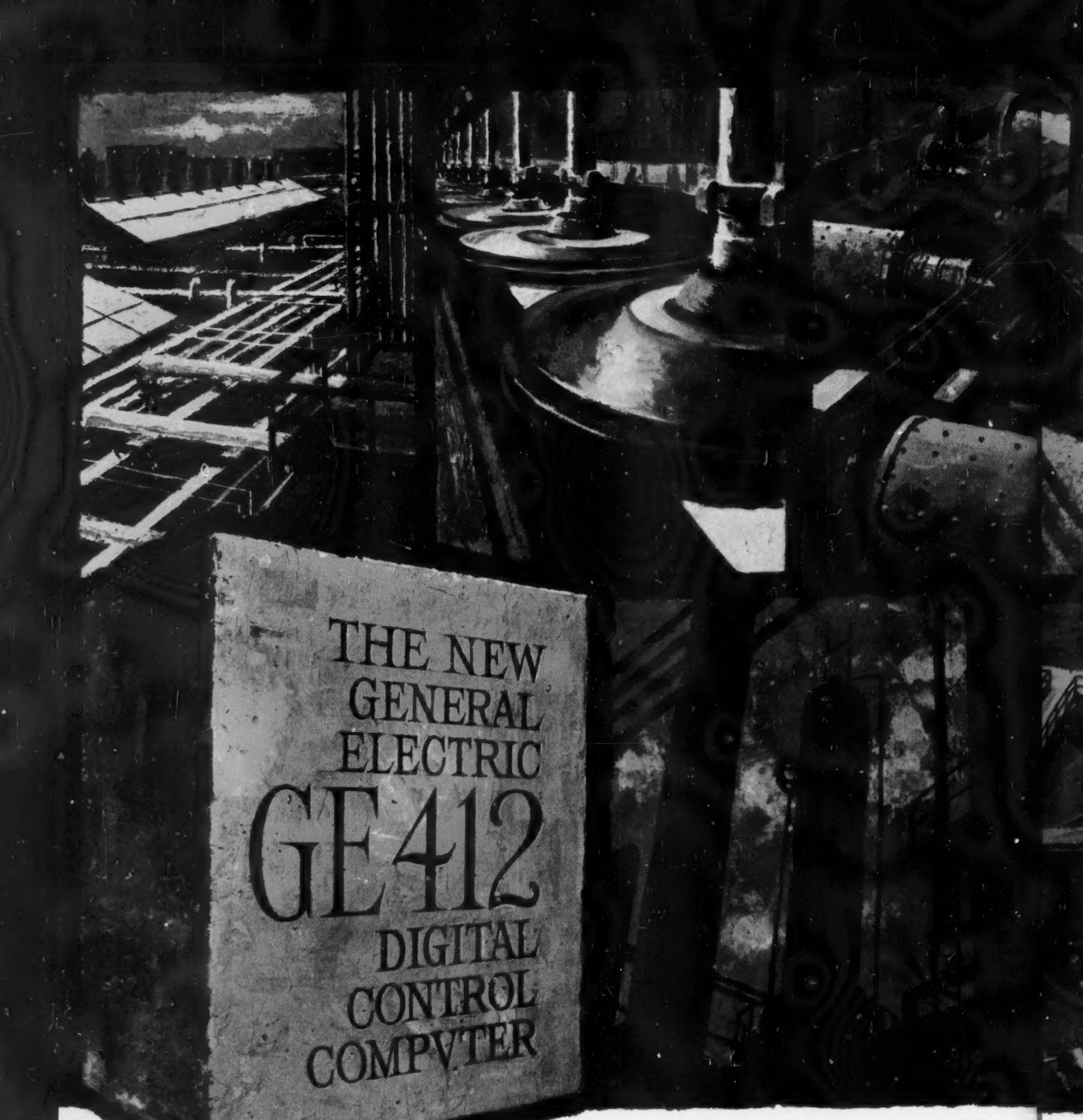

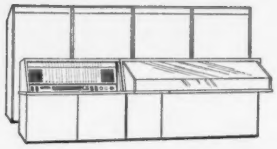

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General Electric announces the new GE 412, a second g eration solid-state, stored program computer designed so for industrial and utility applications.

The GE 412 Digital Control Computer, new "big brot in the General Electric family of process computers, has b designed with the total systems concept and flexibilit equipment organization in mind.

PCA-2

The resultant versatility and capability of the GE 412 makes it custom-adaptable to many particular applications in many varied industries—data-logging and monitoring, data-logging and control, economic dispatching, director (or dispatcher) in a multi-control system.

The new GE 412 is extremely fast—capable of 25,000 additions a second. It incorporates a core memory with drum memory backup, plus more than 100 basic commands, to provide wide programming flexibility. The Automatic Program Interrupt feature and Programmable Elapsed Time Counters permit the regular survey of critical points without wasting valuable computer time required for constant checking.

General Electric offers you the two basic elements for your automation program—the new GE 412 Digital Control computer and the application experience necessary to get operating efficiently in your plant.

General Electric engineers can detail the available full line of input/output equipment and computer services including SYSTEM DESIGN, PROGRAMMING and AIDS, TRAINING, INSTALLATION SERVICES, and MAINTENANCE SERVICES—offered by General Electric to get your automation program in operation quickly... for lower production costs, increased profits.

INVESTIGATE THE NEW GE 412—*contact your nearest General Electric Apparatus Sales Office or the Process Computer Section, Industry Control Department, P.O. Box 2918, Phoenix, Arizona.*
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A pound, or less, of Armoflo® compound will condition a ton of various hard-to-handle dry materials. Applied at an appropriate stage in processing, these liquid conditioners assure free flow of the product in process, function as anti-caking and anti-dusting agents during subsequent handling and storage.

Armoflo compounds may be applied as received, by spraying, dripping or fogging onto the product while it is tumbling in rolling or blending equipment. Armoflos coat each particle with a monomolecular layer that changes hygroscopic surfaces to hydrophobic. They will withstand product heats up to 325° F. and are stable in storage for long periods. Armoflo compounds also provide virtually complete corrosion inhibition for iron and steel processing equipment.

A smoother, faster, more even flow of product results when Armoflos reduce friction between particle surfaces. This lubricating action reduces abrasion and thus reduces "fines" and dust formation.

Armoflos are now being used commercially with a number of products and current testing indicates many more potential applications. The versatility of Armoflo compounds is demonstrated by the following three categories of materials.

FERTILIZERS

Armoflo compounds are effective conditioners for all types of mixed fertilizers —low as well as high analysis grades. The compounds act as anti-dusters on low analysis grades and as anti-dusters and/or anti-cakers in high analysis grades. Armoflos are being used effectively as anti-dusting and anti-caking agents on these typical grades:

Anti-caking and Anti-dusting of High Analysis Grades	Anti-dusting of Low Analysis Grades
0-20-20	0-20-0
5-10-5	3-12-12
5-20-20	3-9-18
7-21-21	3-9-27
7-28-14	4-12-8
10-10-10	4-12-12
12-12-12	5-40-0
15-15-15	8-8-8
17-7-0	10-6-4

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- Ammonium chloride
- Ammonium sulfate
- Diammonium phosphate (21-53-0 and 16-48-0)
- Manure salts
- Monoammonium phosphate
- Nitrate of lime
- Potassium chloride
- Potassium nitrate
- Potassium sulfate
- Sodium nitrate
- Urea (prill & crystal)

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- Dextrin-urea blends
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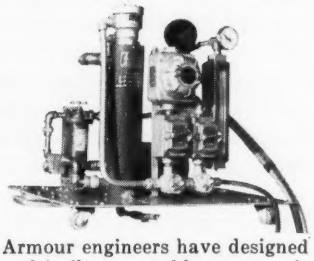
- Glues (mixed, powdered)
- Guar gums
- Hypochlorites
- Insecticides
- Magnesium oxide
- Metallic soaps
- Pentachlorophenol
- Rock salt
- Sodium bisulfate
- Sodium chlorate
- Sodium metasilicate
- Sulfur
- Sylvite
- Thermosetting plastics
- Zinc chloride



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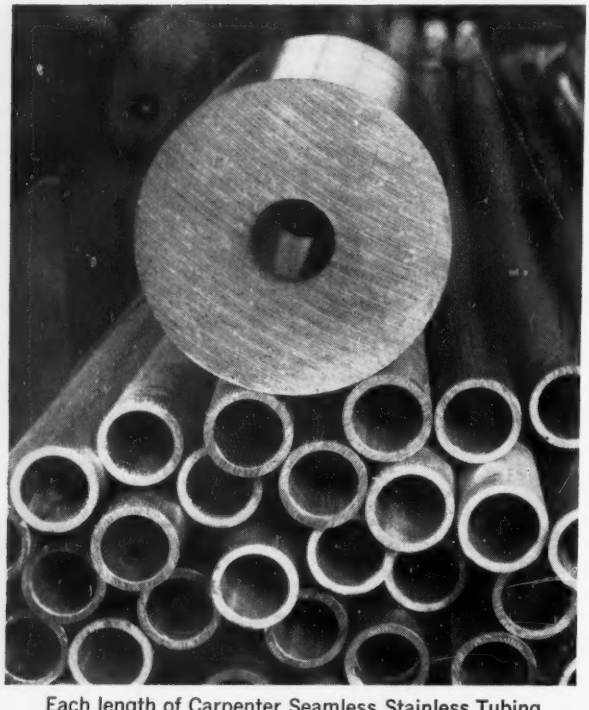

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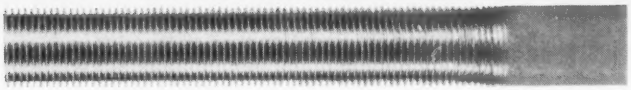
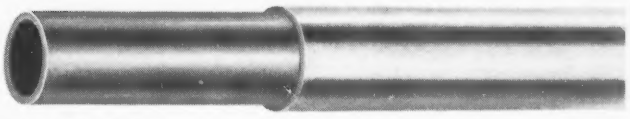
selection geared to service



Integral-Finned Tubing



Bi-Metallic Tubing

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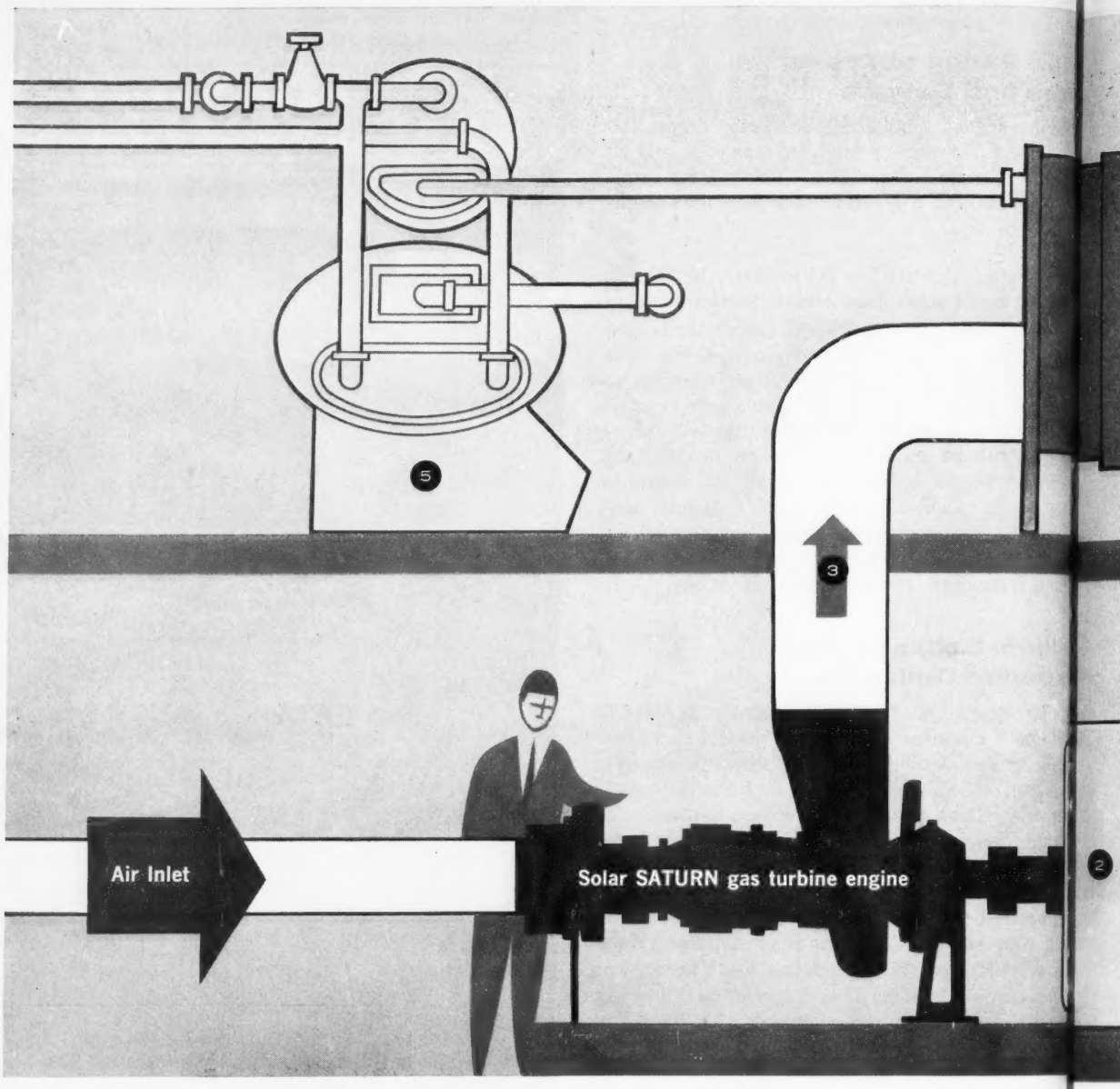
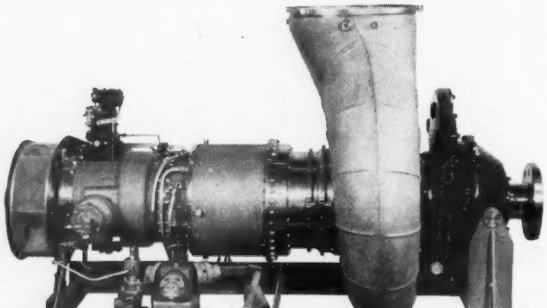
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

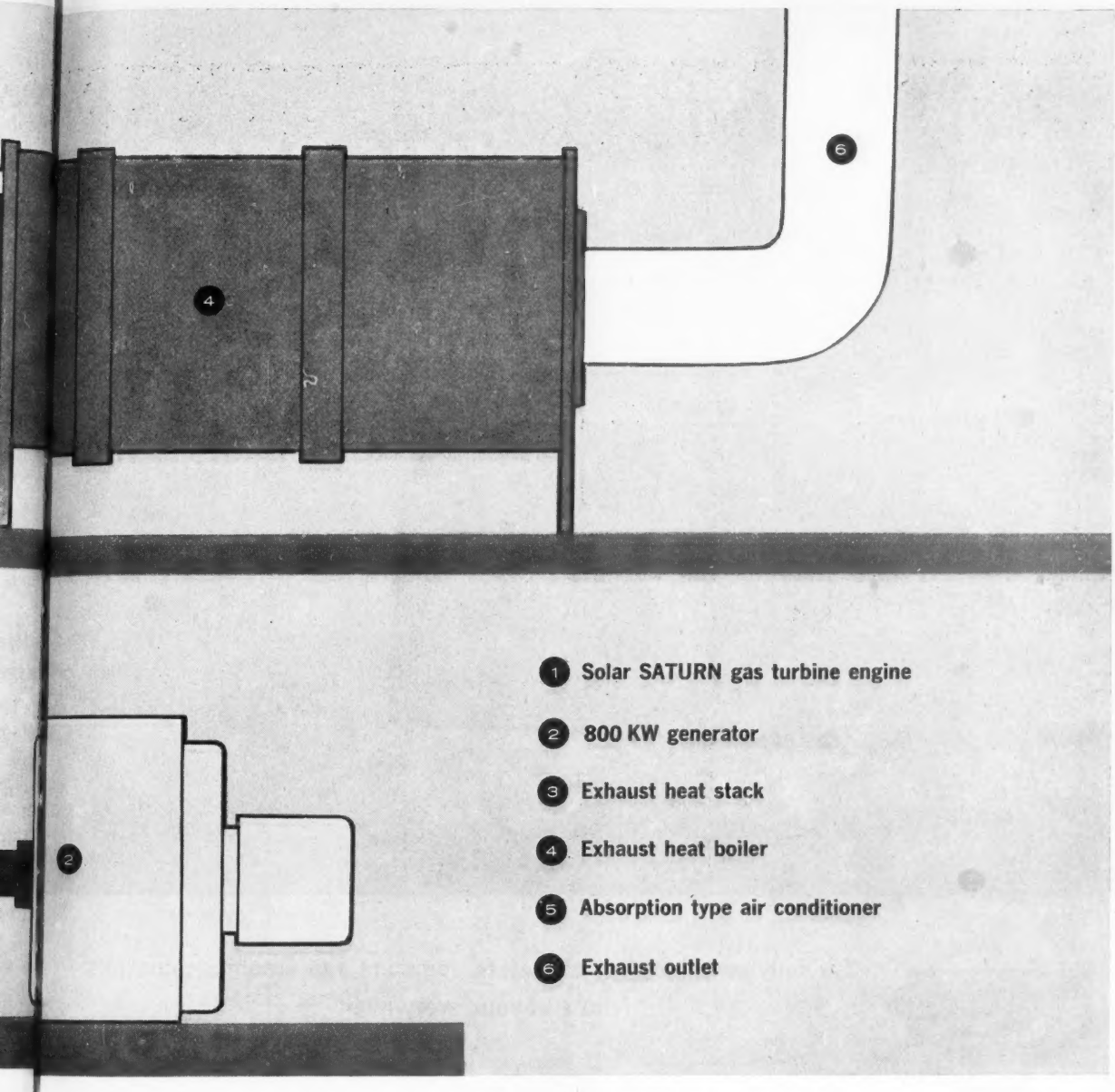


Solar gas turbine exhaust heat mu



This unique system of exhaust energy utilization illustrate d 16,150
one of the many advantages of Solar gas turbines. In addi- s in a 60
tion to the turbine's main shaft power, exhaust gases go to ne, kerose
work to multiply the thermal efficiency of the installation Exhaust
up to three times that of the prime mover alone. y job wh

In the typical system illustrated above, Solar *Saturn* ga anufactur
turbines turn 800 kw generators, providing electricity for Solar gas
lighting and machinery. Turbine exhaust heat is passed ck of vib
through a boiler to provide steam for process or building e ideally
heat and absorption air conditioning. This installation with on, pumpi
three *Saturn* engines produces 2400 kw of electrical energy ing, vehic



1. Solar SATURN gas turbine engine
2. 800 KW generator
3. Exhaust heat stack
4. Exhaust heat boiler
5. Absorption type air conditioner
6. Exhaust outlet

t multiplies thermal efficiency

rates d 16,150 lbs of steam per hour. The complete package
ddi- s in a 60 ft by 40 ft space. The turbines will run on gaso-
go to ne, kerosene, diesel fuel and natural or manufactured gas.
tion Exhaust heat utilization systems are easily adaptable to
y job where electric power generation is needed, such as
gas anufacturing and processing plants.
for Solar gas turbines with their light weight, compactness,
ssed k of vibration, long life and instant start capabilities
ding e ideally suited for such jobs as electrical power genera-
with on, pumping, field and pipeline compression, oil well serv-
ergy ing, vehicle or marine propulsion.

Solar's family of gas turbines, from 50 to 1100 hp, are designed specifically for industrial use. Their design and manufacture are the result of over 15 years of experience. For further information, write to Dept. J-117, Solar Aircraft Company, San Diego 12, California.

SOLAR

A subsidiary of International Harvester Company

...How many tank cars do you lose yearly?

Unless you meter, how can you accurately translate your process losses into loss of profits.

For example, a chemical company making finished products had been carrying "process loss" as a routine accounting entry on their books. They were startled to find that the total of these apparently small losses reached almost 2½ tank cars a year. These were liquids lost or unaccounted for. Leaks, spillage, spoiled batches and perhaps lax plant security measures all were contributing factors.

A meter program, recommended by a Rockwell engineer substantially pinpointed these losses. The result? A marked increase in finished product and most important, *in profits!*

You can use these meters to save money, earn money, to catch leaks and so improve your plant housekeeping and operations. They are the *low cost* way to control liquid inventories and usage—to batch or blend accurately and to improve quality. Since Rockwell meters are made in the widest variety of types and metals (including stainless steel) you can use them to measure practically any liquid that can be piped.

Rockwell liquid meters are sold by jobbers everywhere and backed by our staff of field engineers. Use the handy coupon or write Rockwell Manufacturing Company, Pittsburgh 8, Pa. In Canada, Rockwell Manufacturing Company of Canada, Ltd., Box 420, Guelph, Ontario.

INDUSTRIAL METERS

another fine product by

ROCKWELL

CLIP COUPON MAIL TODAY

Rockwell Manufacturing Company
Dept. 130-G, Pittsburgh 8, Pa.

Gentlemen:
Please have your field engineer call ( )

I am interested in measuring_____
(Name of Liquid)

Pipe size_____"

Working pressure_____psi Temperature_____°F max.

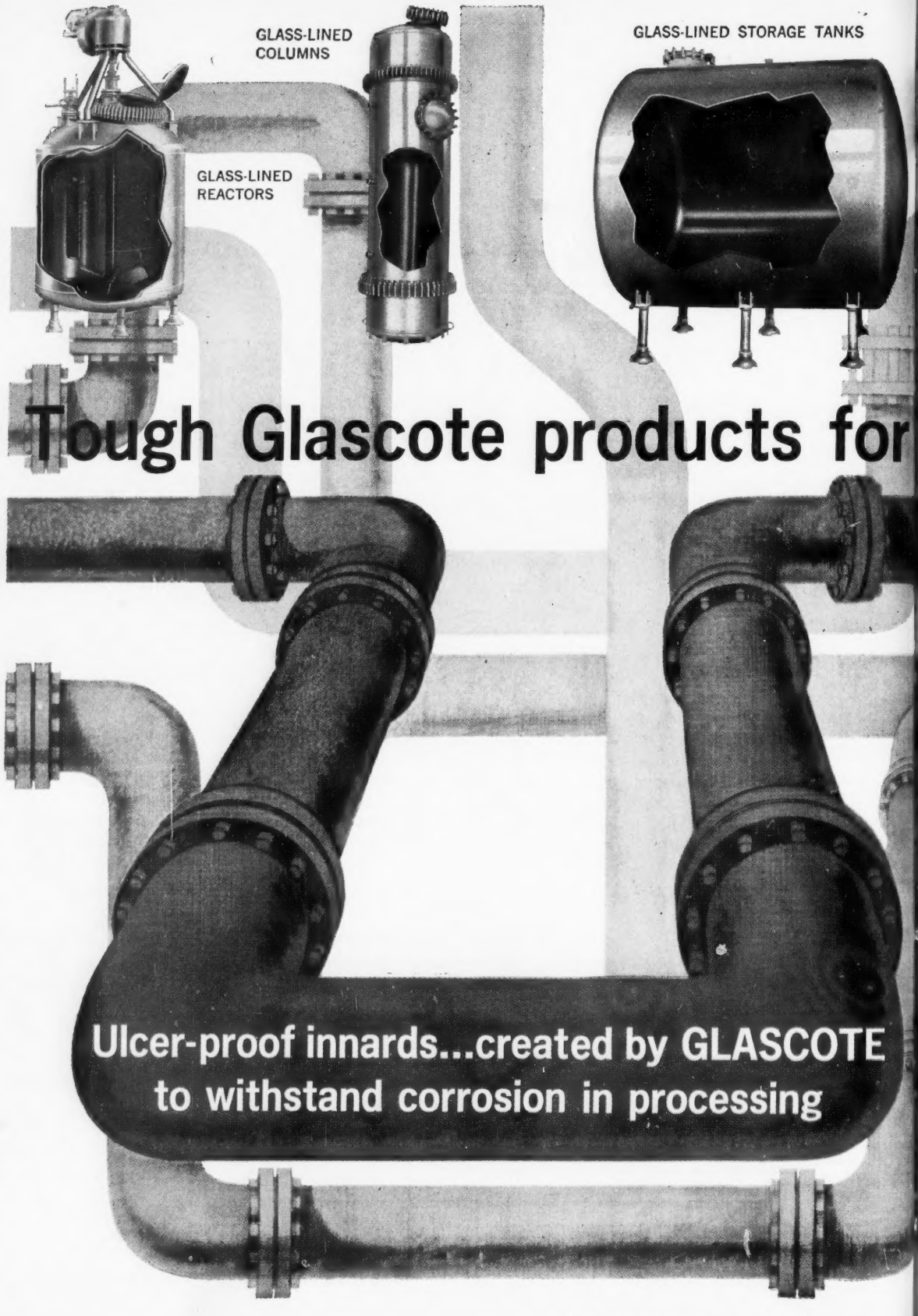
Max. flow rate_____gpm Min. flow rate_____gpm

Your Name_____

Company_____

Street_____

City_____ Zone_____ State_____


GLASS-LINED COLUMNS
GLASS-LINED STORAGE TANKS
GLASS-LINED REACTORS
Tough Glascote products for ev
Ulcer-proof innards...created by GLASCOTE to withstand corrosion in processing

or every stage of your process

Glascote products give a process reliable protection against corrosive agents and contamination. Glass-lined protection means extra years of service . . . lower operating costs.

Glascote glass-lined equipment guarantees product purity . . . greatest versatility for processing products . . . new outstanding resistances to acids. Vessels lined with Glascote's unique 778, for example, extend acid resistance to 75° F higher operating temperature. And 778 is only one of more than 3000 Glascote glass-lining formulations.

Glascote offers complete engineering service, too! Each process is thoroughly analyzed by highly experienced Glascote experts who make specific mechanical proposals carefully worked out to individual needs. And after the installation has been made, Glascote backs it up with personal, direct, prompt maintenance care.

For efficient, economical, reliable glass-lined processing equipment, insist on Glascote . . . insist on a long life for your process!

Get specific product data from your Glascote representative. Or, send for new Glascote Products Bulletin No. 105. Glascote Products, Inc., Cleveland 17, Ohio.

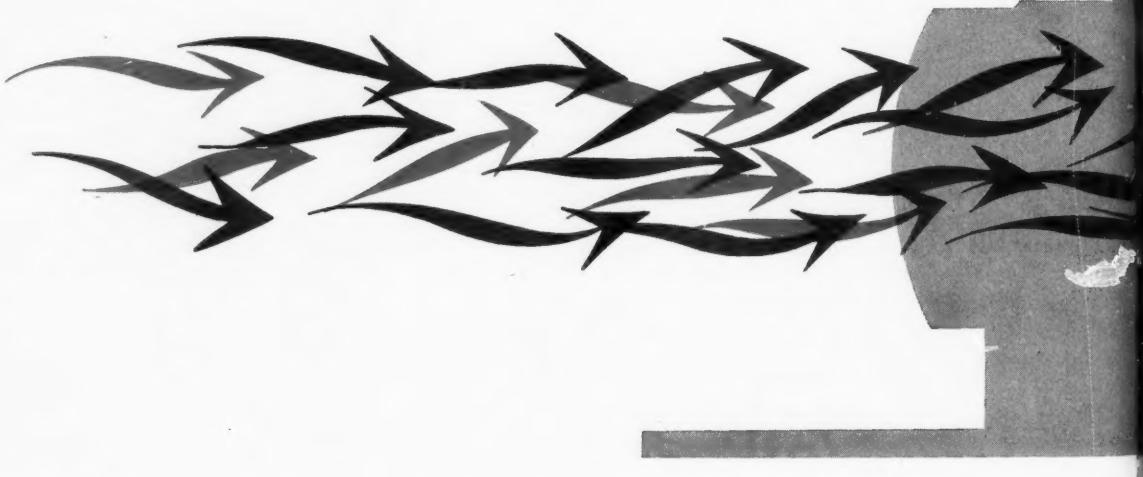
Through research A.O. Smith *. . . a better way*

A.O.Smith
CORPORATION

Subsidiary
GLASCOTE PRODUCTS, INC.
Cleveland 17, Ohio
World's largest manufacturer of glass-protected steel products.

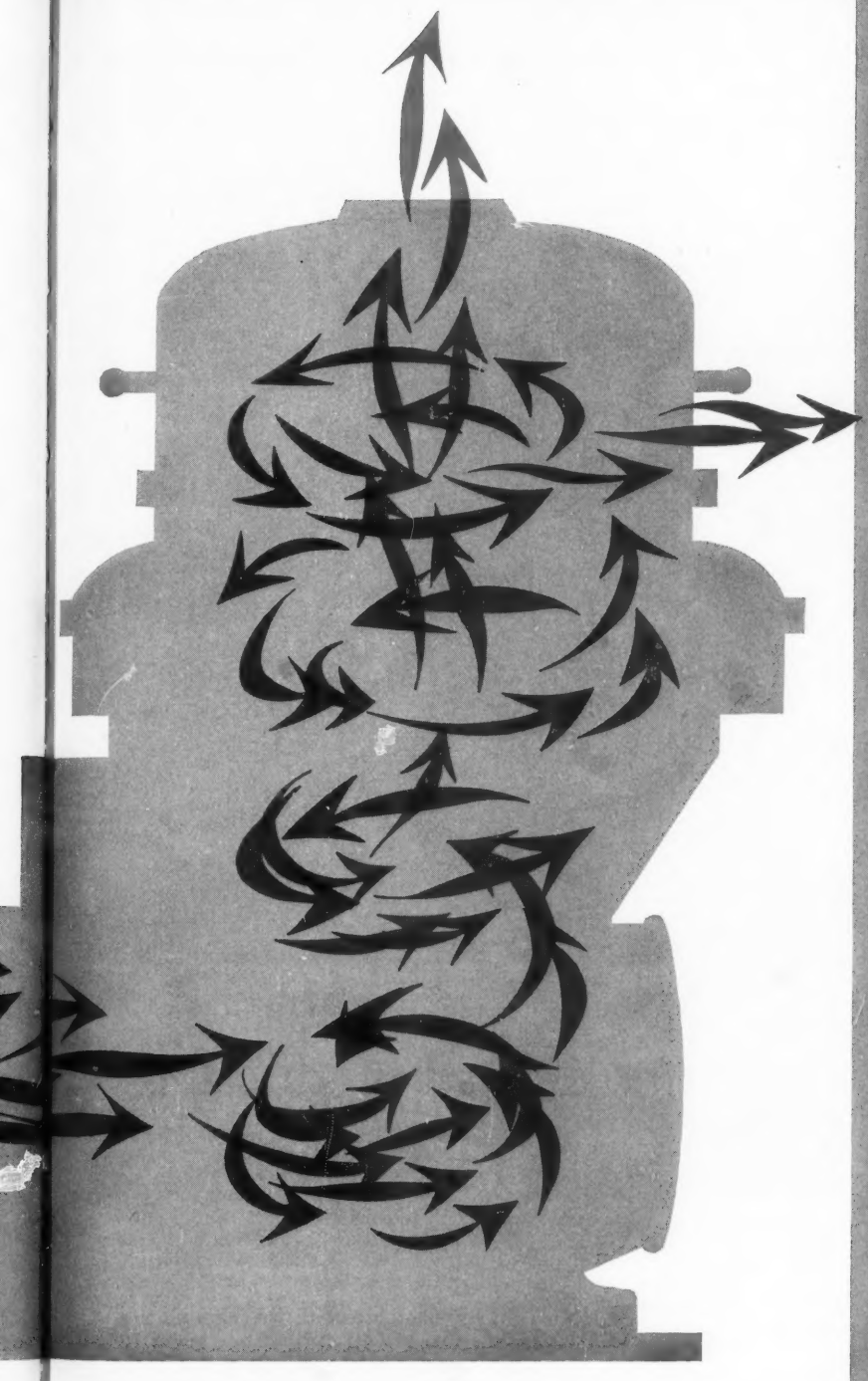
6000 G's give instant on-stream separation or clarification in

DE LAVAL PROCESS CENTRIFUGES



Modern on-stream separation of liquid-liquid phases is as simple as this: pipe the product mixture into the process centrifuge. It is instantly separated into its heavy and light phases, which are continuously discharged. Tremendous gravity forces are used to provide the wide range of liquid-liquid-solid separations described here. These separations are finding rapidly expanding applications in continuous-flow processing—replacing bulky settling tanks and batch filter systems. More important, De Laval Process Centrifuges perform separations of types and efficiencies not previously possible—opening up entirely new process potentials. Information on many such processing modernizations is available from De Laval.

A sound look at your own present or planned



process by a De Laval engineer can quickly determine the process benefits and economies. Start by requesting our booklet on centrifuge types and their applications.

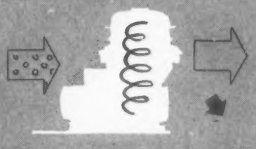
THE DE LAVAL SEPARATOR COMPANY

Poughkeepsie, N. Y.
5724 N. Pulaski, Chicago 46, Ill.
201 E. Millbrae Ave., Millbrae, Cal.
DEPT. CE-7

DE LAVAL

BASIC PROCESS APPLICATIONS:

LIQUID-LIQUID: Separations of immiscible liquids range from removing trace moisture in oils to high-flow-rate separation of reaction product mixtures. Volatile liquids can be processed under pressure.



LIQUID-SOLIDS: Suspended solids of any fineness are instantly removed to give crystal clear product streams. Sediment is removed periodically for disposal or recovery. When suspended solids represent a significant proportion of the product stream, the solids can be removed continuously and automatically by specially designed De Laval centrifuges.

LIQUID-LIQUID-SOLIDS: The removal of sediment or solids in no way affects or handicaps the separation of immiscible liquids where such 3-phase systems exist.

PROCESS DESIGN FACTORS: Materials of construction can be matched to operating conditions. Operating pressures up to 150 lbs. p.s.i. can be handled, permitting efficient processing of volatile and air sensitive materials. Capacities of De Laval's Process Centrifuges range from 2 to 12,000 gallons per hour—and the very largest requires only 12 sq. ft. of floor space.

FLUIDICS* AT WORK

Pfaudler factory inspector electric-tests **Nucerite** bayonet heater (6⅝" dia. by 68" long) designed for experimental use in high-temperature sulphuric acid environment.

Progress report:

NUCERITE moves into limited production

Now, there is a practical way to cope with a broad range of corrosives in the 500 to 1500°F temperature range.

It's Pfaudler® Nucerite,* a recently developed family of ceramic-metal composites that resist corrosion at these high temperatures.

Various formulations of Nucerite have undergone field testing on a wide scale since this group of materials was introduced last year. Results indicate many practical applications for Nucerite in the 500 to 1500°F range. Very few materials available up till now would withstand these temperatures, and even then only under extremely limited conditions.

Limited production. Where field tests or lab data substantiate the serviceability of Nucerite in a given application, Pfaudler now accepts orders for production equipment of simple shape, rounded corners, and uniform cross section.

Successful tests. You can get some idea of the range of applications for Nucerite from this representative list of successful field tests:

1. Metal halides at 1292°F (a specialty alloy failed in this service in 2 to 3 weeks).
2. Cl_2 and CCl_4 mixture at 600°F (a quarter-inch stainless steel piece corrodes through in a matter of minutes).
3. Refractory metal chlorides at 485°F.
4. Coal tar pitch at 750°F (solid ceramic materials previously used failed here due to thermal shock).
5. Aqua regia plus heavy abrasive at 225°F (tantalum is the only metal which could withstand this condition).
6. HCl plus solids (100 f.p.s.) at 1112°F.

Nucerite equipment. Among the equipment for which orders have already been received, are the following: 6"-diameter pipe, 2½"-diameter boiler tube, 6⅝"-diameter bayonet heater (shown above), 12"- and 18"-diameter columns, finger baffles, and a 300-gallon "RA" series closed-top reactor.

Other characteristics. Nucerite offers the greatest potential in coping with corrosion at high temperatures. However, resistance to impact, abrasion, and rapid temperature change is also of importance for specific applications.

Data available may indicate which formulation of Nucerite can best solve your particular problem. If not, we invite your participation in a field evaluation program.

For more information, write to the address shown on the facing page.

*Patent applied for

Only 10 days from here to your plant

That's the delivery story on selected Pfaudler Glasteel reactors.

In standard sizes and assemblies you can get the reactor you need, shipped to your plant, just 10 days after receipt of your order.

This "off-the-shelf delivery" applies to completely assembled Glasteel reactors in lab, pilot-plant and production sizes. Specifically, it covers the following: "P" series reactors in 30-, 50- and 100-gallon sizes; "E" Series in 200-, 300- and 500-gallon sizes; and "RA" series in 500-, 750-, 1000- and 2000-gallon sizes.

Complete specifications for these reactors are covered in Bulletins 927, 971 and 988, respectively.

Of course, all of these reactors bring you the many desirable features of Glasteel. Long life in corrosive service, since Glasteel is resistant to all acids (except HF) to 350°F and most alkalies at moderate temperatures. An essentially inert product-contact surface that protects purity, quality, and color. And a hard, smooth surface that resists build-up and is easy to clean.

When you need a reactor in a hurry, take advantage of the fast delivery and operational flexibility provided by Pfaudler's pre-stocking program.

In all, you can choose from 29 different standard models of Glasteel reactors, ranging in size from 1 to 4000 gallons. Normal delivery quoted, except as indicated here.

Write for free bulletins.

Why have wipers in an evaporator?

You'll find four wipers like this one in the Pfaudler Wiped Film Evaporator.

Their job: Wetting the entire evaporator wall with a *uniform*, thin film.

The result: High thermal efficiency and excellent heat transfer when you evaporate products that are heat sensitive, highly viscous, or low in thermal conductivity.

Free-floating, the blades are held in contact with the evaporator wall by centrifugal force. Note the slots—they

prevent curl and help accelerate product movement down and off the wall.

This gives you the best combination of full utilization of heat transfer area, an ultra-thin film for highest "U" values, and very short contact time at elevated temperatures.

The Pfaudler Wiped Film Evaporator is a high-capacity production unit, able to provide you with an evaporation rate of up to 50 lbs/hr/sq ft of heat transfer area, based on water.

Choose from standard models with 4 to 100 sq ft of evaporating area. If you need something larger, we'll fabricate on a custom basis.

Offer: Let us test your product at our Test Center. Or start by evaluating the data and specs in Bulletin 991.

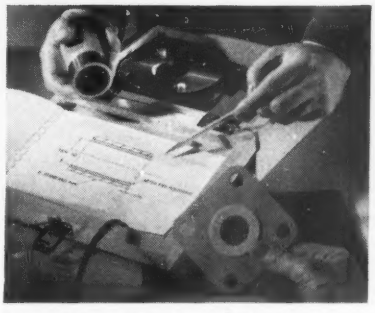
Address all inquiries to our Pfaudler Division, Dept. CE-71, Rochester 3, N. Y. *In Canada, contact Pfaudler Permutit Canada Ltd., Toronto.*

Special gasket assures precise alignment for F-C Glasteel pipe*

This is the high-integrity glass-lined pipe that you can cut, thread, fire-polish and install right in the field. And to make sure that gaskets seat properly when you join sections, we've taken special precautions to assure precise alignment of the pipe axes.

Here's how: Flange bolt holes have been made *only* 1/16" oversize, rather than the conventional 1/8" oversize. In addition, the bolt holes in the gasket itself have also been made *undersize*. The gasket is thereby centered with the axial center line of the pipe and limits non-parallelism of the flanges.

Both the pipe and the gasket joints have been extensively tested — in the field and in our Test Center. For example, intermittent tests over a seven-month period were made with the following acids: 10% sulphuric, 10% nitric, and 20% hydrochloric. Pressures ranged



from 50 to 125 psi, with temperatures from 160 to 300°F. *There were no failures of either the glass lining or the gaskets.* Similar results have been reported for actual installations, including one of 850 feet, in operation since early last summer.

You'll find F-C pipe well suited to handling many "problem" liquids—corrosive, abrasive, and ultra-pure. It comes in 1½-, 2- and 3-inch diameters, with quick delivery on any length up to 10 feet. Write for Bulletin 987.

*Patent applied for

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

A DP TRANSMITTER

212T TRANSCOPE® Indicating Flow and DP Transmitter gives you all the features you expect from a truly fine DP Transmitter . . . and the only one that can be calibrated linear with flow as well as differential pressure without changing parts.

Taylor Instruments

R OF MANY USES !

New Taylor 212T Transmitter is first and foremost a superior DP Transmitter . . .

Taylor's 212T TRANSCOPE® Transmitter is an outstanding example of "all this and heaven too". Basically it is a sound DP Transmitter, but when used for flow it can be calibrated to give a linear output without additional parts. It's available in indicating or non-indicating models. And with all its superior features *you pay no premium in price.*

Check the highlights listed here, then call your Taylor Field Engineer for a demonstration and write for **Bulletin 98413.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.

Liquid-filled primary unit means:

Positive overrange protection. Hydraulic overrange protection to full body rating in *either* direction.

Isolation of internal parts. Working parts—except diaphragms themselves—are exposed only to non-corrosive silicone oil.

Built-in damping. Effective pulsation damping occurs at frequencies greater than approximately 2 cycles per second.

Exceptional rangeability.

Normal range span is 20 to 250" water. However, superior design and engineering quality permits over-calibration in either direction with good performance.

Mounting and connection versatility for any installation.

Process connections can be at top, at back or at bottom. ½" NPT fittings set on 2⅛" centers for convenience in piping directly to standard orifice flange taps. Universal mounting bracket can be secured to standard 2" horizontal or vertical pipe, or bolted to flat surface.

Good, clean mechanical design.

Diagonally split case makes all calibration adjustments easily accessible by simply removing cover. Zero adjustments can be made externally. Sturdy, protective case, designed for field locations.

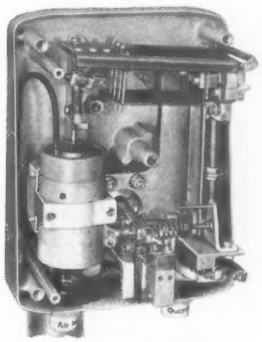
PLUS

Servo power for square root extraction.

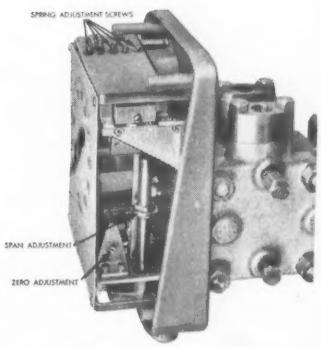
Produces an output directly proportional to flow or differential pressure . . . a cost-and time-saving feature when applied to computer control, or ratio and cascade control systems.

Servo power for indication accuracy.

Powerful servo relay drives tape movement to provide indication on a big 11¾" scale. It eliminates the necessity for externally mounted receiver gages.



Open case design provides free-access for maintenance.



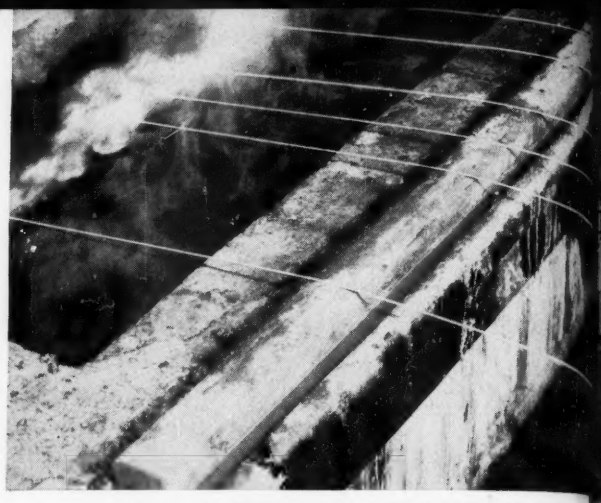
Diagonally split case gives easy access for all adjustments.

Non-indicating model, showing rear mounting and bottom process connections.

MEAN ACCURACY FIRST

Report from Carborundum:

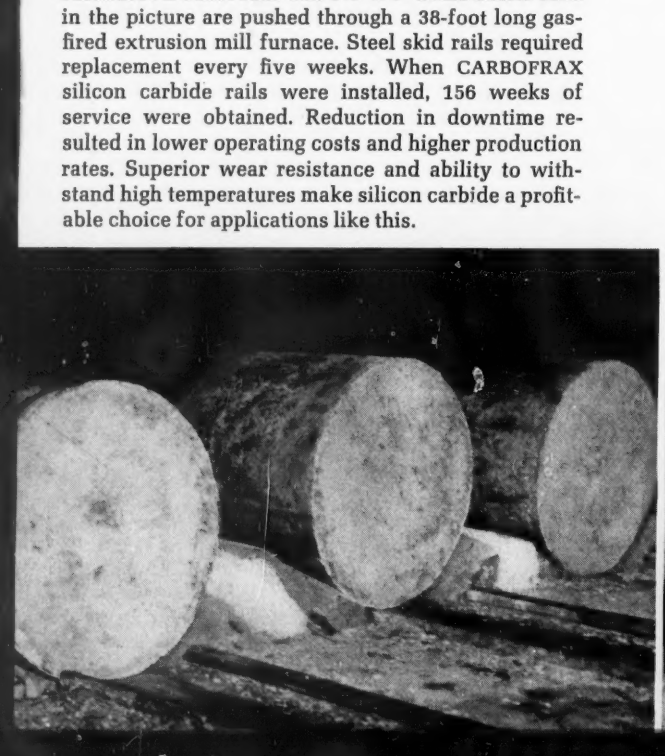
6 ways to do jobs better with refractory materials

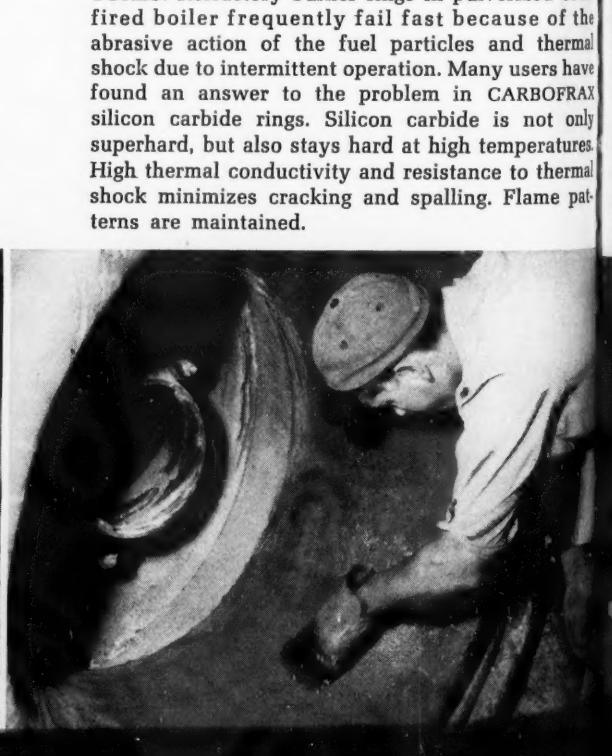


HANDLING MATERIALS IN ACID SOLUTIONS:
SILICON CARBIDE WEAR BLOCKS RESIST CORROSION AND ABRASION. Steel wire moving at 100 ft/min passes over CARBOFRAX® silicon carbide wear blocks to a pickling tank in the photo above. A 15% solution of sulfuric acid at 400 F is used. Sinker blocks are also of CARBOFRAX silicon carbide. Despite the action of the acid and the abrasion of the wire, the silicon carbide shows no wear after months of service. Similar applications involving Carborundum refractories are found in aluminizing and other wire coating baths.

SKID RAILS IN REHEAT FURNACE:
SILICON CARBIDE RAILS LAST 30 TIMES AS LONG AS STEEL IN HIGH TEMPERATURE, ABRASIVE SERVICE. The 6¾" x 8" brass billets seen in the picture are pushed through a 38-foot long gas-fired extrusion mill furnace. Steel skid rails required replacement every five weeks. When CARBOFRAX silicon carbide rails were installed, 156 weeks of service were obtained. Reduction in downtime resulted in lower operating costs and higher production rates. Superior wear resistance and ability to withstand high temperatures make silicon carbide a profitable choice for applications like this.

LONGER LIFE FOR BURNER RINGS:
SILICON CARBIDE CONSTRUCTION WITHSTANDS FLAME EROSION AND HIGH TEMPERATURES. Refractory burner rings in pulverized coal-fired boiler frequently fail fast because of the abrasive action of the fuel particles and thermal shock due to intermittent operation. Many users have found an answer to the problem in CARBOFRAX silicon carbide rings. Silicon carbide is not only superhard, but also stays hard at high temperatures. High thermal conductivity and resistance to thermal shock minimizes cracking and spalling. Flame patterns are maintained.





DIRT-FREE
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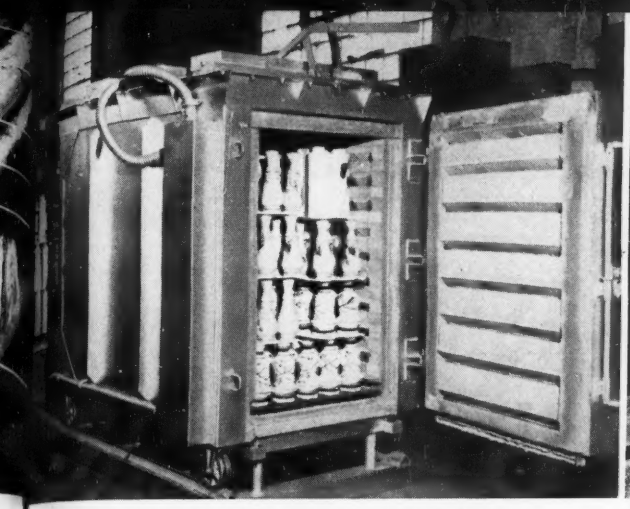
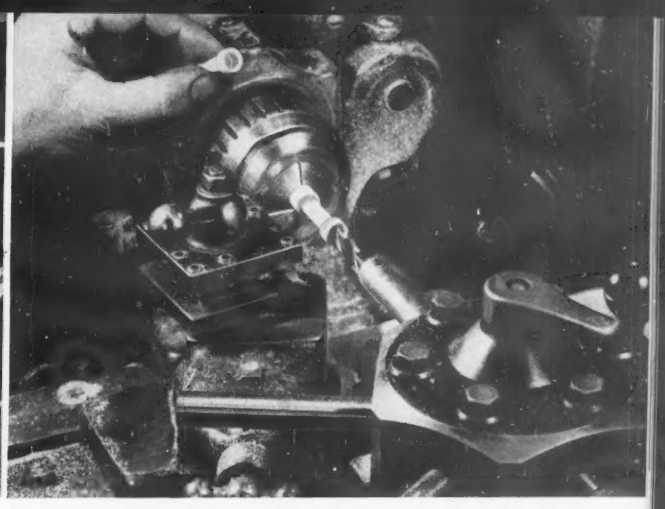


DIRT-FREE OPEN FIRING WITH MOVABLE KILN:

FIBERFRAX® CERAMIC FIBER LINING REPLACES BRICK: MAKES POSSIBLE TEMPERATURES UP TO 2200 F. The interesting movable kiln illustrated is made by Unique Kiln Co., Hillsdale, N. J. It moves on rails to enclose a stationary loading bed. Two beds can be serviced alternately. Door and hood linings of Carborundum's light-weight FIBERFRAX ceramic fiber, in block form, eliminate the problem of dislodged dirt and dust encountered with fireclay type refractories, which often damage ware being fired. High heat resistance and insulating properties of FIBERFRAX fiber make possible firing up to 2200 F.

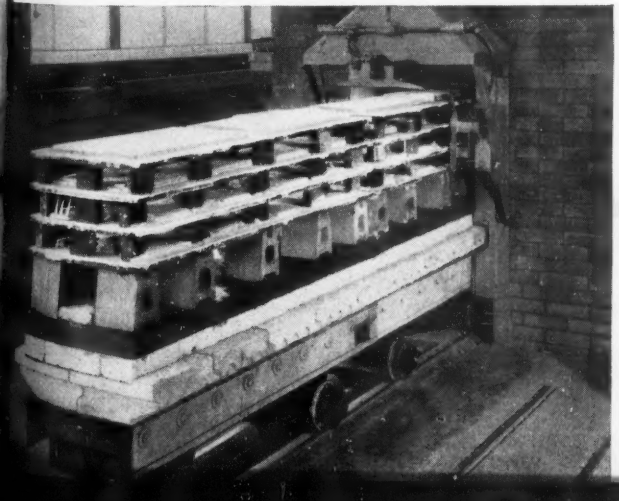


SHAPES AND JIGS MACHINED FROM CERAMIC:

BORON NITRIDE IS EASILY MACHINED; RESISTS HIGH TEMPERATURES AND CORROSION. The photo shows the machining of a semi-conductor jig from Boron Nitride, a self-bonded material made by Carborundum. Close tolerances, high surface finish and intricate detail are possible. Boron Nitride offers advantages in semi-conductor production compared with graphite jigs, yields from which often drop 40% after only 50 cycles. The material also offers possibilities for insulating tubes and shapes; chemical equipment parts, crucibles, brazing fixtures, gaskets and seals. Shapes withstand furnace temperature of 3000 F; powder as high as 5400 F.

ELIMINATING CRACKING IN KILN CAR TOPS:

COMBINATION OF REFRACTORIES SOLVES PROBLEM IN CERAMIC INDUSTRY. Used in a gas-fired electrical porcelain kiln, the cars illustrated have been in service for more than two years at cycles of 14 to 15 hours, operating from cold to 2290 F to cold. Car top cracking due to heat shock has been eliminated by use of three different Carborundum refractories—a bottom layer of MULLFRAX® electric furnace mullite for high load carrying capacity, a middle course of ALFRAX® alumina "bubble" brick for insulation and an upper course of CARBOFRAX silicon carbide tile for resistance to thermal shock.



Want help on your problems?

Carborundum engineers will be glad to recommend refractories to answer your specific needs.

For information, contact Dept. H-71, Refractories Division, Carborundum Co., Perth Amboy, N. J. Descriptive brochures available on request. Please specify the area or areas of particular interest to you.

for engineered refractories...count on

CARBORUNDUM®

ASK PHILADELPHIA

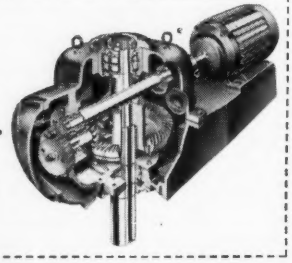
It takes mixing know-how to handle high rate gas/liquid contacting. You may need multi-speed motors to combine the right torque during gassing with overload protection at no gas flow. Philadelphia engineers can tell you for sure.

Or the mix may demand extra-generous freeboard for expansion during absorption. Ask us. Philadelphia engineers know mixing. And what isn't known about a brand-new process, our laboratory and research staff finds out . . . fast.

Good General Rule: In gas/liquid mixing, always supply enough torque for the liquid to disperse the gas and prevent binding or flooding of impellers, then add power as your process requires.

Best General Rule: Ask Philadelphia about mixers *and* mixing. Philadelphia Mixers do what they're sold to do. Philadelphia Mixers *mix.*

Here's the Secret of trouble-free mixing: gears precision-ground to master gear perfection. Tougher, quieter, more powerful—the best mixer drives made are made by Philadelphia.



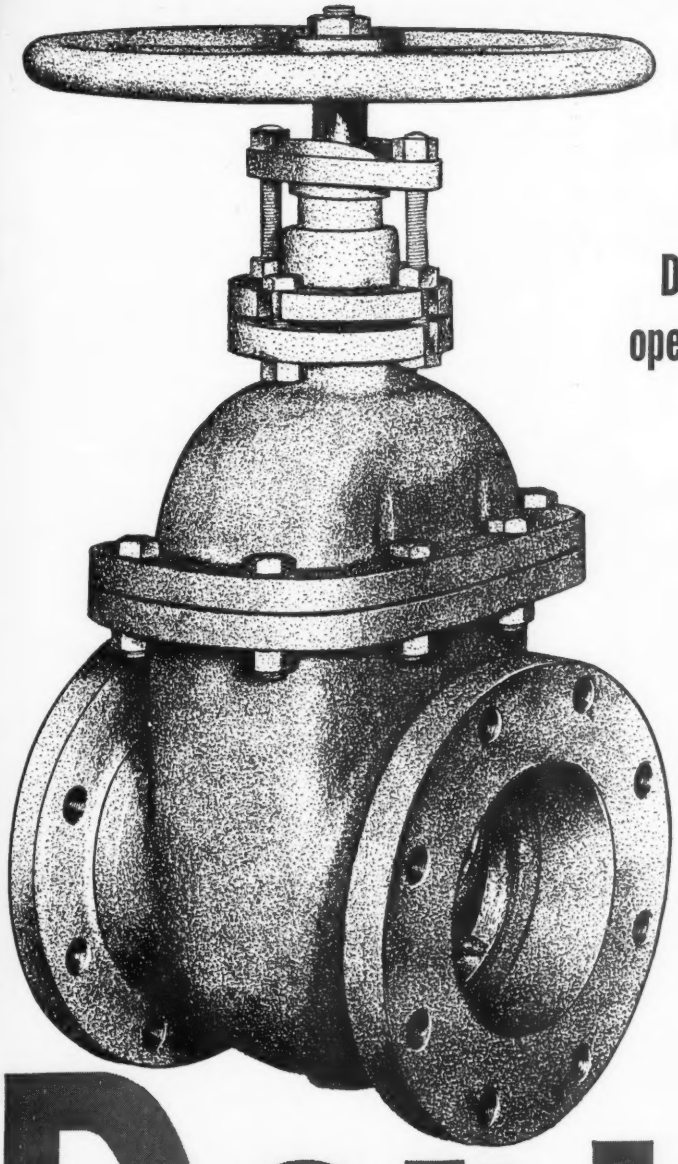
Get Facts—and plenty of them—on mixer design, construction, and specification. Sections on *Fluid Mixing Practice* and *Process Mixing Technology* detail steps you can take to improve process efficiency. Read how to change gears in minutes for speeds from 20 to 280 RPM. Request 64-page Bulletin A-19 on your letterhead today.

PHILADELPHIA MIXER

DIVISION OF PHILADELPHIA GEAR CORPORATION
King of Prussia (Suburban Philadelphia), Pennsylvania

AGMA MEMBER

ASK ANY ENGINEER / GEARS ARE THE HEART OF A MIXER



Dependable Darling Gate Valves open fully, close tight—with ease

The fully revolving double disc parallel seat and wedge design minimizes friction, avoids concentration of wear, and automatically compensates for valve seat deflection.

Gate discs are independently hung and free to revolve. They change their seating position at each closing. All working parts are perfectly plain. There are no pockets to collect sediment or prevent free and easy movement.

For assured ease of operation, minimum maintenance, long trouble-free service life, *you can depend on Darling*. Our engineers are always glad to assist you in determining the right valves for your service conditions. Darling Catalog No. 57 gives complete specifications. Write for your copy today.

DARLING VALVE & MANUFACTURING CO.
Williamsport 3, Pa.

Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario, Canada
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France

YOU CAN DEPEND ON

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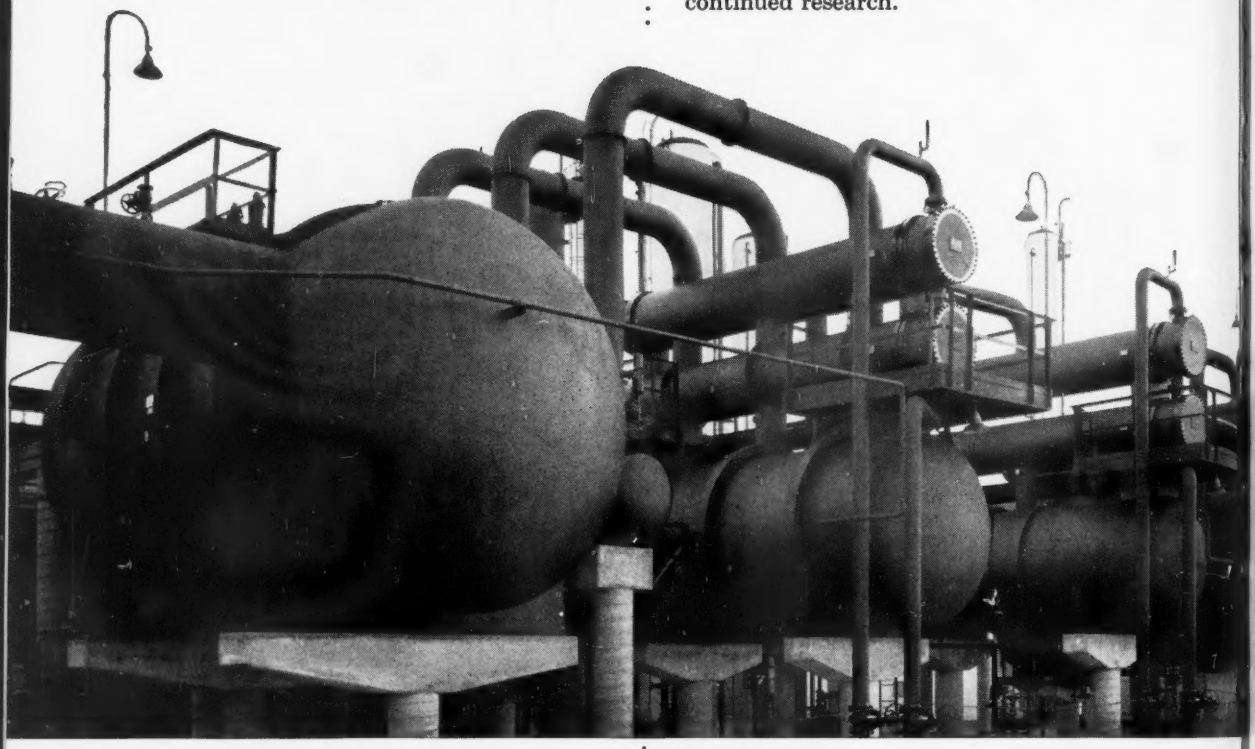
A Complete, Proven Line

Do your structures need protection from moisture? High temperature? Low temperature? Corrosion? Escaping heat? Whatever your protection problem, there is a Lion Nokorode Coating designed to solve it.

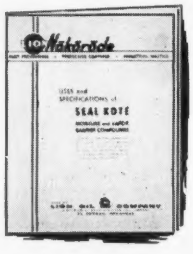
Tough, durable Lion Nokorode Protective Coatings can be sprayed on regular or irregular surfaces faster than most coatings. They adhere at any angle, and change shape without rupturing. These coatings are constantly proved and improved throughout world-wide use and continued research.



Lion Nokorode Seal Kote protects vessels and pipes from corrosion in a modern chemical plant.

The Best Technical Information

While developing the complete line of Nokorode Coatings, Lion Oil and its parent company, Monsanto Chemical Company, also have developed the most complete file of technical information in the industry. Tell us your problem. We will send you the technical literature which applies. Just mail the coupon.



Technical Booklet gives uses and specifications of Lion Nokorode Seal Kote and application techniques.

Protective Coatings Section
LION OIL COMPANY
A Division of Monsanto Chemical Company
El Dorado, Arkansas

My protective coatings problem is.....

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Please send me the appropriate technical literature.

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A DIVISION OF MONSANTO CHEMICAL COMPANY
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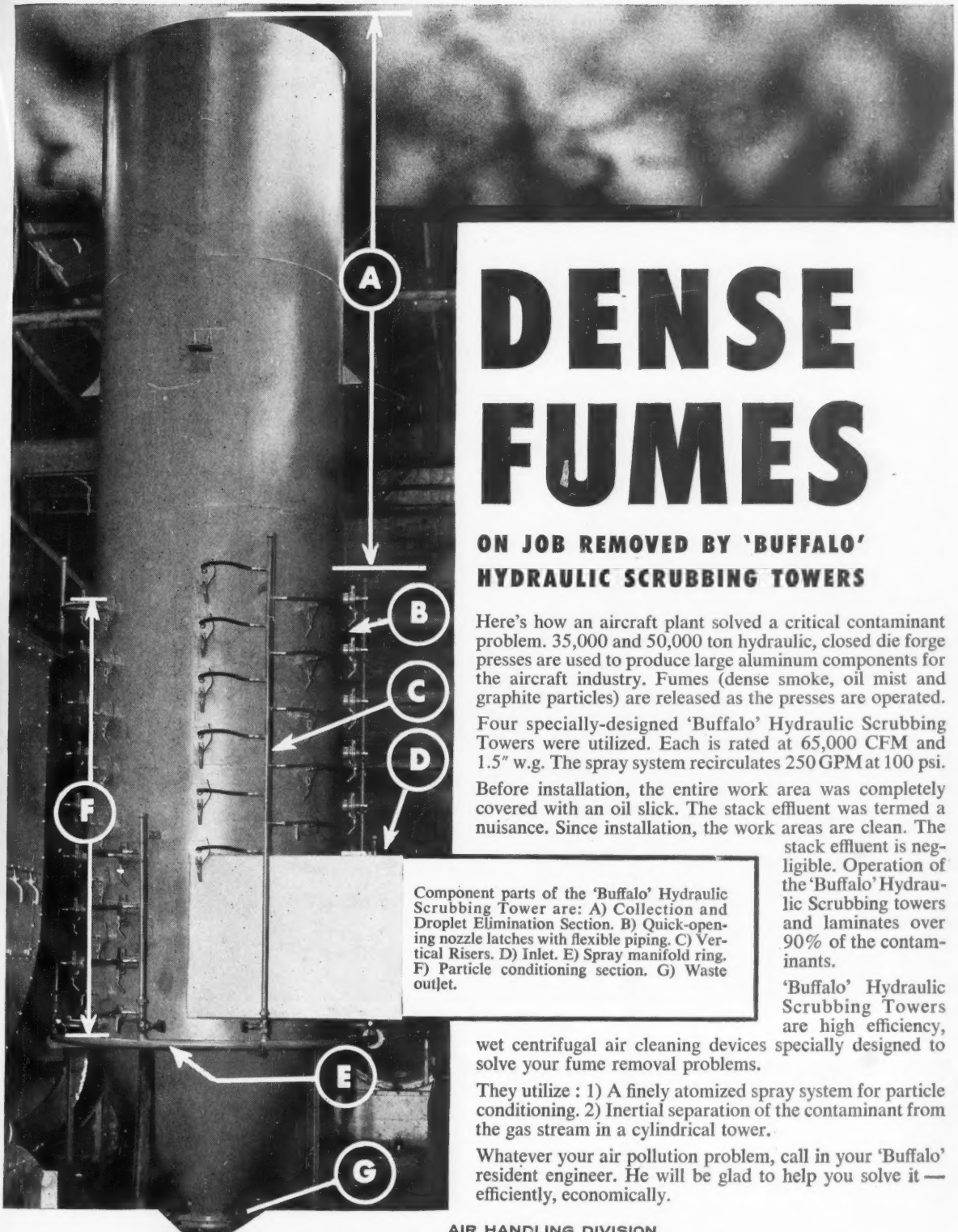


DENSE FUMES

ON JOB REMOVED BY 'BUFFALO' HYDRAULIC SCRUBBING TOWERS

Here's how an aircraft plant solved a critical contaminant problem. 35,000 and 50,000 ton hydraulic, closed die forge presses are used to produce large aluminum components for the aircraft industry. Fumes (dense smoke, oil mist and graphite particles) are released as the presses are operated.

Four specially-designed 'Buffalo' Hydraulic Scrubbing Towers were utilized. Each is rated at 65,000 CFM and 1.5" w.g. The spray system recirculates 250 GPM at 100 psi.

Before installation, the entire work area was completely covered with an oil slick. The stack effluent was termed a nuisance. Since installation, the work areas are clean. The stack effluent is negligible. Operation of the 'Buffalo' Hydraulic Scrubbing towers and laminates over 90% of the contaminants.

Component parts of the 'Buffalo' Hydraulic Scrubbing Tower are: A) Collection and Droplet Elimination Section. B) Quick-opening nozzle latches with flexible piping. C) Vertical Risers. D) Inlet. E) Spray manifold ring. F) Particle conditioning section. G) Waste outlet.

'Buffalo' Hydraulic Scrubbing Towers are high efficiency, wet centrifugal air cleaning devices specially designed to solve your fume removal problems.

They utilize : 1) A finely atomized spray system for particle conditioning. 2) Inertial separation of the contaminant from the gas stream in a cylindrical tower.

Whatever your air pollution problem, call in your 'Buffalo' resident engineer. He will be glad to help you solve it — efficiently, economically.

AIR HANDLING DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

Corrosion is licked here . . . why quit when you're ahead?

You may be using PYREX® pipe now for your most corrosive applications.

Think about putting it to work wherever you carry *any* corrosive liquid, or fluids that must go through without contamination.

Put these advantages in every line: Low installed cost that repays itself quickly in maintenance and replacement savings, in reduced down time. Chemical inertness that prevents corrosion and contamination. Thermal shock strength that lets you pump through hot-cold-hot. Transparency that makes easy maintenance even easier, allows for constant visual inspection of flow.

PYREX pipe throughout will give you room to move, too. Switch line applications as you will, knowing every line can handle anything you put in it.

Write to Plant Equipment Department, 8907 Crystal Street, Corning, N. Y. for our Bulletin PE-3. It gives you full details.

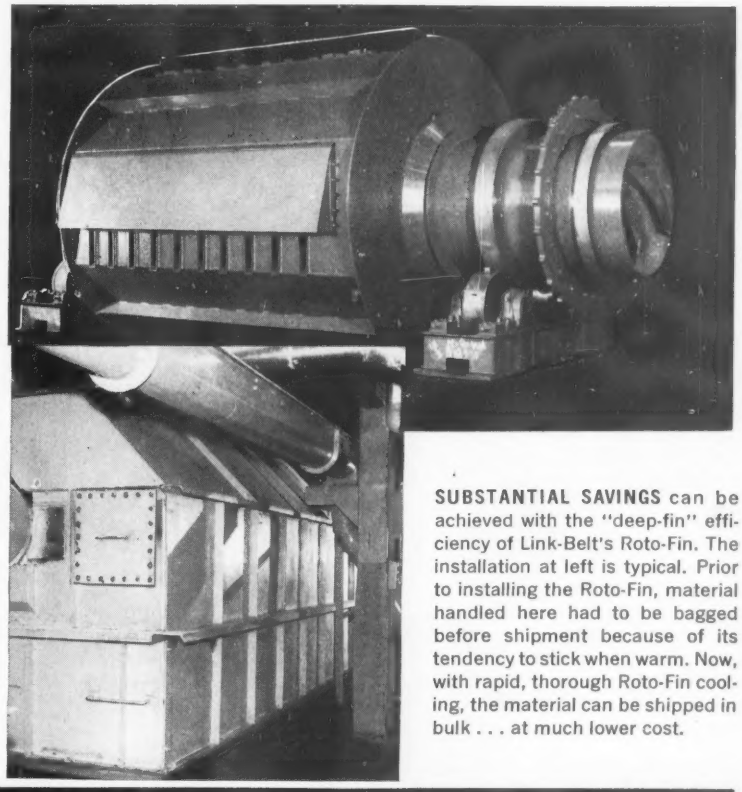
CORNING GLASS WORKS
CORNING MEANS RESEARCH IN GLASS

LINK-BELT Roto-fin HEAT EXCHANGER

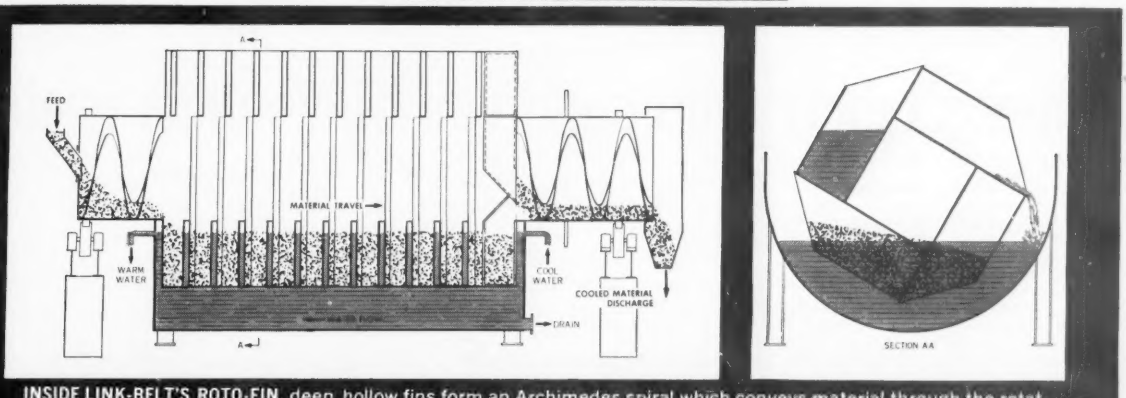
High-volume conduction cooling or heating in a simple, compact design

Link-Belt's Roto-Fin heat exchanger offers *new efficiency, new economy* for cooling or heating bulk materials. Deep, hollow fins provide *more heat-transfer area per unit than other exchangers of comparable diameter and length!*

Roto-Fin can be made in *many* diameters and lengths—depending on plant layout and type of process, as well as amount of heat transfer required. A laboratory-size Roto-Fin is available for in-plant testing. Make arrangements by calling your nearest Link-Belt office. And ask for new Roto-Fin Folder 2911.



SUBSTANTIAL SAVINGS can be achieved with the "deep-fin" efficiency of Link-Belt's Roto-Fin. The installation at left is typical. Prior to installing the Roto-Fin, material handled here had to be bagged before shipment because of its tendency to stick when warm. Now, with rapid, thorough Roto-Fin cooling, the material can be shipped in bulk . . . at much lower cost.



INSIDE LINK-BELT'S ROTO-FIN, deep, hollow fins form an Archimedes spiral which conveys material through the rotating drum. Outside, the fins scoop and discharge water (or other cooling agent) with each revolution. This continually cools the surfaces in contact with the hot material. With this type of action it is possible to realize overall heat-transfer coefficients as high as 20 btu/hr./sq. ft. /deg. F.

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LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses and District Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World. 15.652

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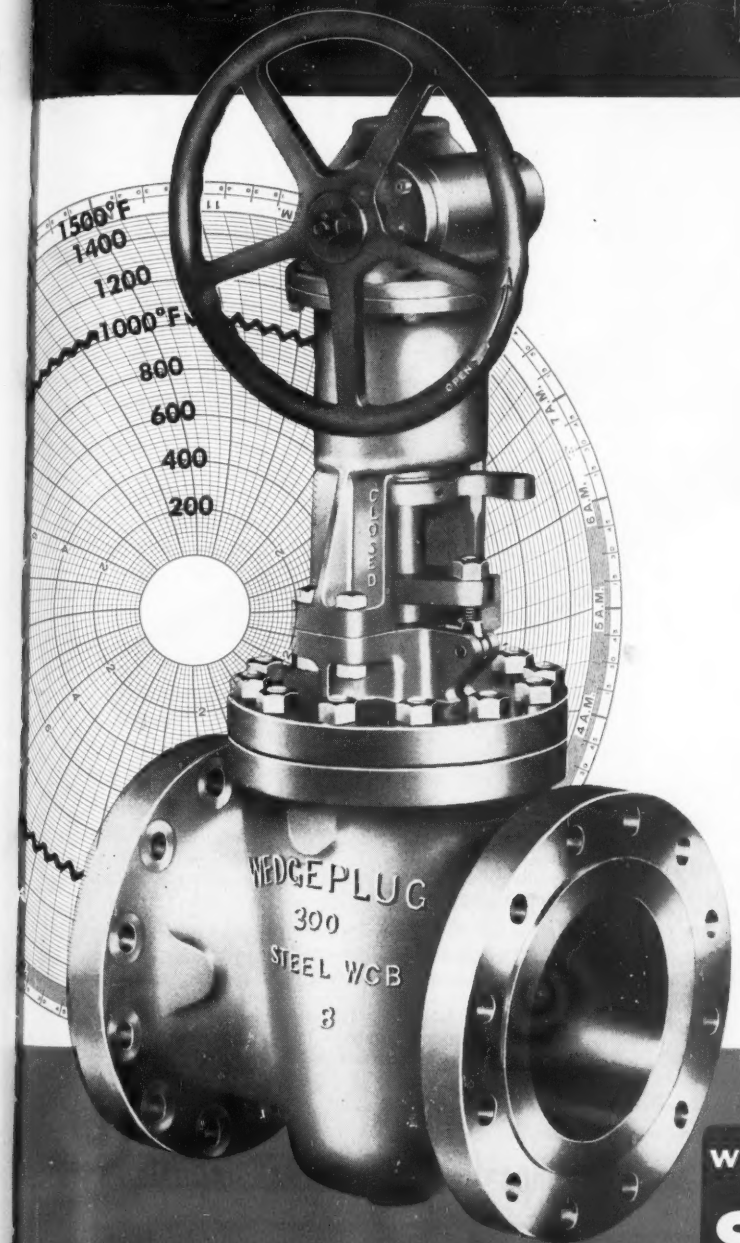

WEDGEPLUGS
give positive control without lubricants

Wedgeplugs are proven performers on coking and catalyst lines:

No lubricants required for absolute control. Plug lifts, turns and reseats in one quick, easy operation.

Non sticking. Self-adjusting operator compensates for variable temperature. Will not stick on coking services.

Protected seats prevent valve-killing erosion of dry and fluid catalysts—a constant problem and expense when gate valves are used. With Wedgeplugs, you eliminate this extra maintenance cost.

Wedgeplugs are proven performers on such services as hydrocarbon vapors at 900°F and 600 psi; fluid catalysts at 1125°F and 225 psi; and hydrogen at 900°F and 300 psi. Wedgeplug valves can be supplied in alloy steels as service demands.

Non-lubricated plug valves • Cast iron, malleable and ductile iron pipe fittings • Bronze, cast iron, ductile iron, cast and forged steel valves

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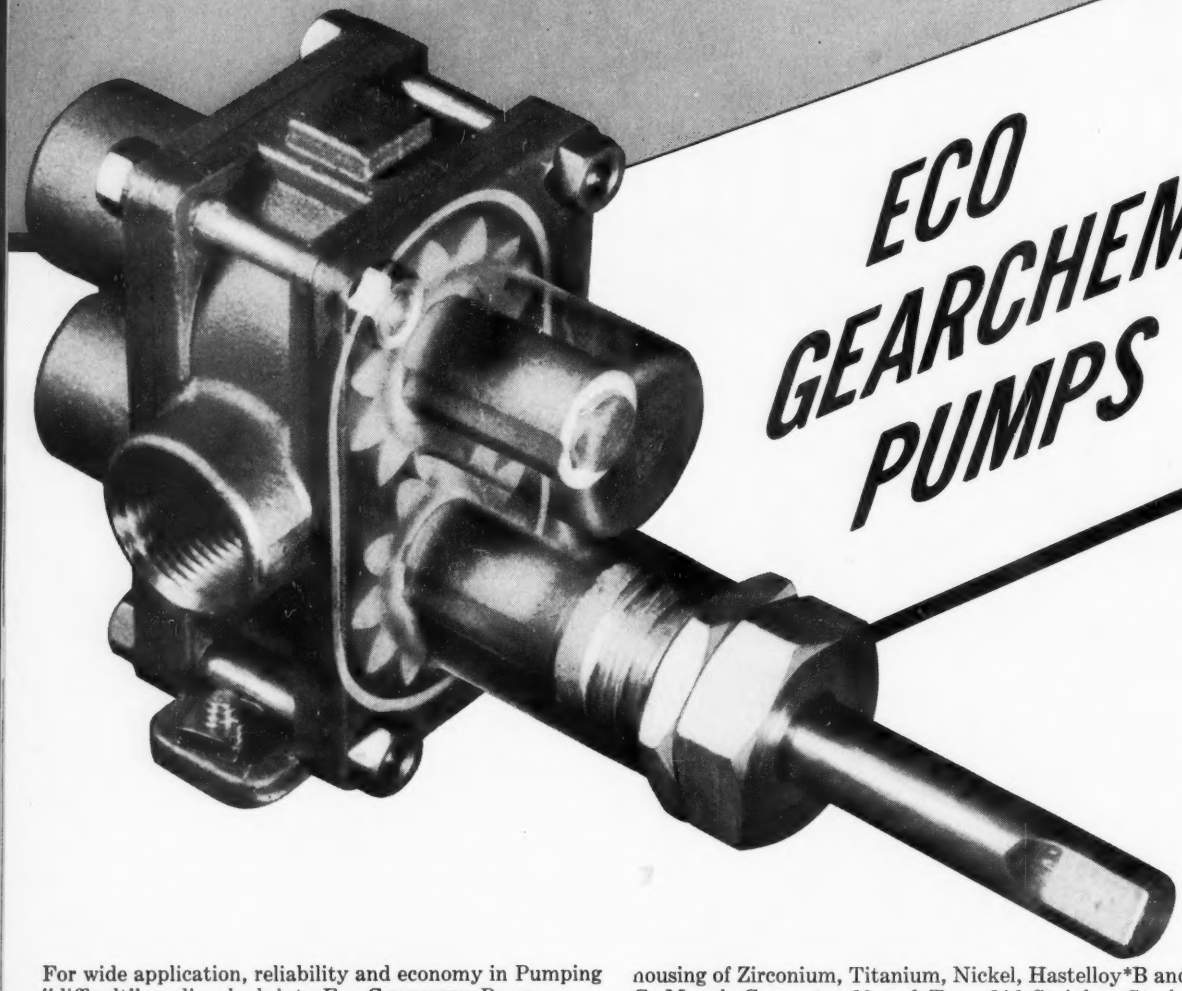


ECO GEARCHEM PUMPS

For wide application, reliability and economy in Pumping "difficult" media—look into Eco GEARCHEM Pumps.

Handle acids in most concentrations (including hot HCl and H_2SO_4); alkalies; solvents; viscous resins (to 30,000 SSU); mercury, etc.

Flow rates to 10 gpm with pressures to 100 psi. Ideally suited for closed loop systems operating under either high vacuum or pressure and wide temperature ranges. Self-priming. Suction pressures to 5 mm abs. Self lubricated by the medium pumped.

Standard stock pumps, immediately available, with housing of Zirconium, Titanium, Nickel, Hastelloy*B and C, Monel, Carpenter 20 and Type 316 Stainless Steels.

Equipped with interchangeable gears of Teflon†, Penton‡, phenolic and polyamide resins, synthetic hard rubber and Hastelloy B or C. Packings of Teflon or Teflon in combination with other suitable plastics, in conventional or lantern ring stuffing box.

Eco GEARCHEM Pumps are mass produced on the latest automatic "program" machine tools to pass on to you optimum quality and service at lowest cost.

Write for Literature on any or all of the Eco stock pumps shown below for handling corrosive or hazardous processing fluids.

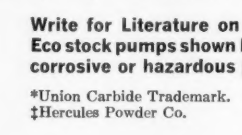
*Union Carbide Trademark. †du Pont Trademark.
‡Hercules Powder Co.

ECO

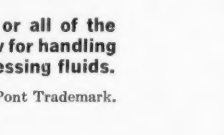
the big-name in small pumps for the process industries

CENTRI-CHEM LINE

ALL-CHEM LINE



GEARCHEM LINE



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- HIGH TEMPERATURE WITHOUT PRESSURE . . .

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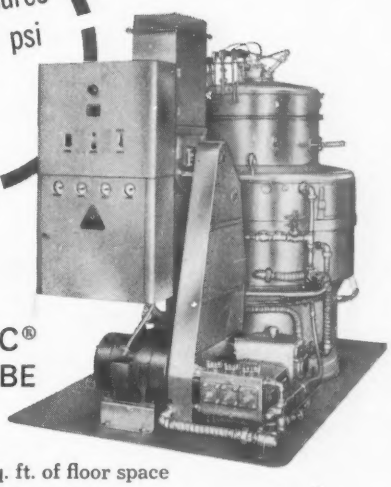
HAS THE ANSWER!

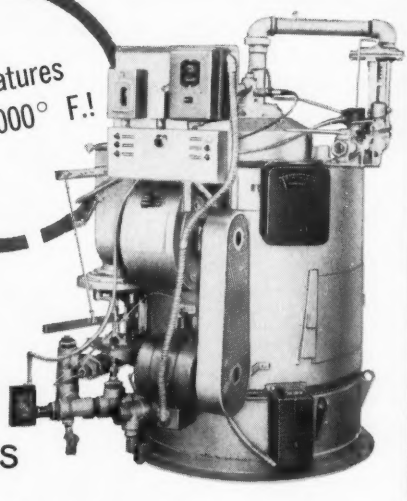
steam pressures to 900 psi or higher!



VAPOR MODULĀTIC® WATER-TUBE BOILERS

- Compact—40 sq. ft. of floor space
- Fully automatic operation
- Completely packaged, fully wired
- 18 to 150 hp
- Ideal for multiple-unit installations

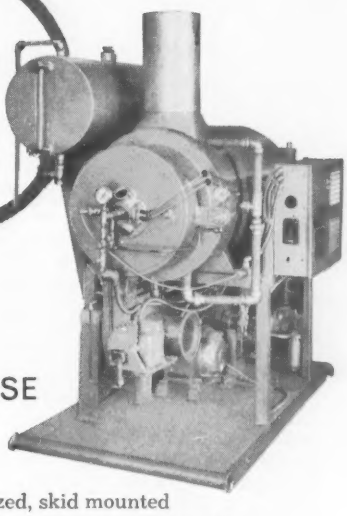
steam temperatures 600° to 1000° F.!



VAPOR STEAM SUPER-HEATERS

- Compact—16 sq. ft. of floor space
- Automatic operation
- Meets ASME and other codes
- Constant temperature control
- Completely assembled and wired

600° temperatures without pressure!



VAPOR HI-R-TEMP* LIQUID PHASE HEATER

- Completely unitized, skid mounted
- Accurate, automatic temperature controls
- Eliminates need for water treatment
- Low-pressure vessels and flow circuits
- Sizes to 13,000,000 b.t.u.

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80 East Jackson Boulevard, Chicago 4, Illinois.

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- ☐ **Modulātic Water-Tube Boilers**
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in at top...out at bottom

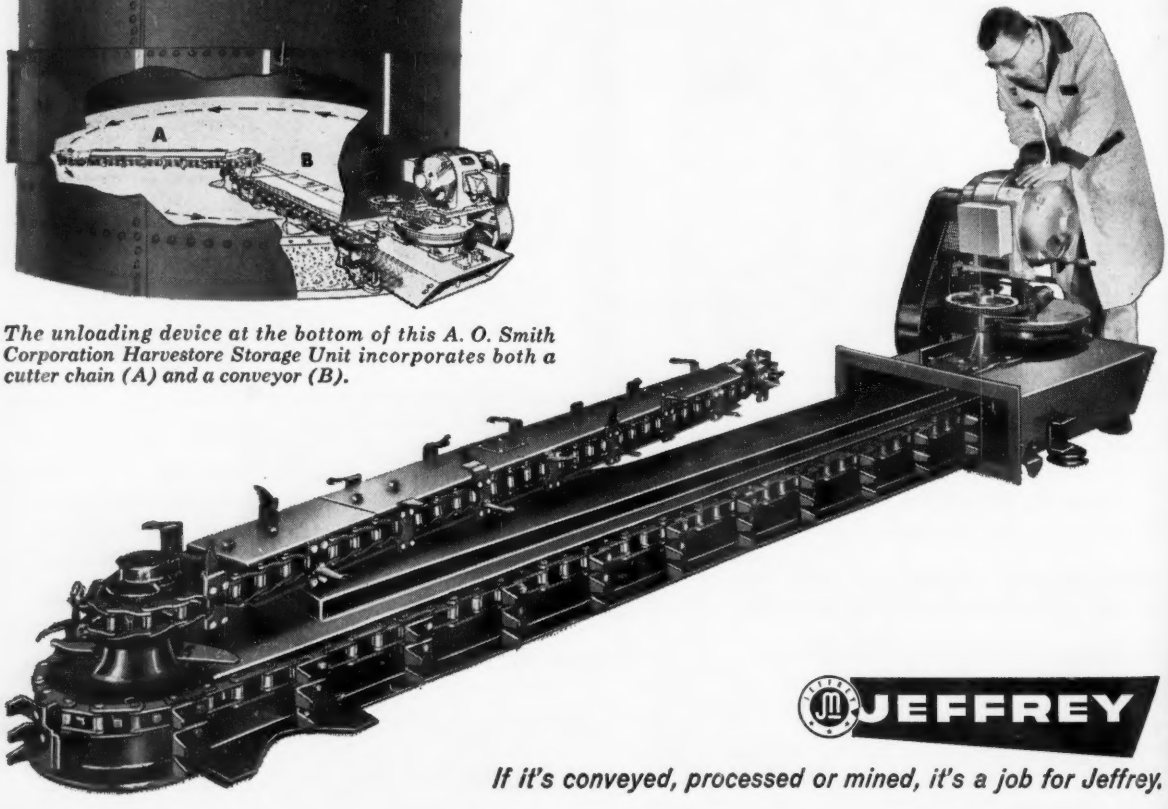
Sweep-arm unloader mechanizes Harvestore materials storage

This mechanical bottom unloader provides an efficient means for feeding out tons of free-flowing bulk material—even though additional tons of farm or industrial materials may be loaded on top. As the sweep-arm passes around the bottom of the unit, cutters attached to its chain loosen tightly packed material and move it to the center. There it drops to another subfloor chain conveyor and is carried outside.

Two types of Jeffrey chain contribute to the dependable performance of the Harvestore Unit. STR chain on the sweep arm has special attachments on which cutters are mounted. Both the cutter chain and the Jeffrey Combination Chain used on the conveyor are unusual, in that they operate on their side, thereby requiring a quality product.

Jeffrey chain is designed for hard service—built for rugged going—whether employed for power transmission, conveying or digging. For engineering assistance in applying Jeffrey chain to your equipment, write The Jeffrey Manufacturing Company, 909 North Fourth Street, Columbus 16, Ohio.

The unloading device at the bottom of this A. O. Smith Corporation Harvestore Storage Unit incorporates both a cutter chain (A) and a conveyor (B).



JEFFREY

If it's conveyed, processed or mined, it's a job for Jeffrey.

now try this one for SIZE!

A 7000 cfh* line-mounted Rootsmeter less than 18″ long

Now you can have the advantages of both rotary-positive-displacement metering and line-mounting in a 7000 cfh Rootsmeter, Model 7M125, as well as in the already widely accepted 3000 cfh model.

Rootsmeters are accurate through wide ranges of pressure and flow—unaffected by fluctuations. And because of Roots proved operating principle, you can be sure the accuracy is permanent.

The new meters are designed for easy line-mounting. The 7000 cfh model is less than 18″ long, and the 3000 cfh model is only 14″ long. Connections are flanged to ASA C.I. standards, and line-mounting Rootsmeters require no special supports for simple horizontal or vertical installation.

There are a lot of other advantages in these Line-Mounted Gas Meters, too. You can easily read total flow through the convenient protective lens of the direct-reading volume register, yet the register itself is enclosed entirely within the meter case, eliminating problems incurred with external counters. And if you wish, the meter can be easily instrumented. Maintenance is simple: just replenish the oil occasionally; convenient bulls-eye oil-level gauges make checking easy. There are no internal valves, orifices, or diaphragms to wear or be damaged, and no stuffing boxes to maintain. Testing is easy too, with simple connections provided for standard proving procedures.

Whether your problems are in gas production, transmission, or distribution, or if you meter industrial or institutional gas, you'll find Line-Mounted Rootsmeters the most accurate and dependable, easiest to install, and most convenient gas meters you've ever used. Call your Roots-Connersville engineer or write for details of all the advantages of new Line-Mounted Rootsmeters.

*Dial Rate

ROOTS — DRESSER INDUSTRIES INC. — OIL • GAS • CHEMICAL ELECTRONIC • INDUSTRIAL

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Working together in allied industries . . .

CLARK® — Engines, Compressors, Gas Turbines

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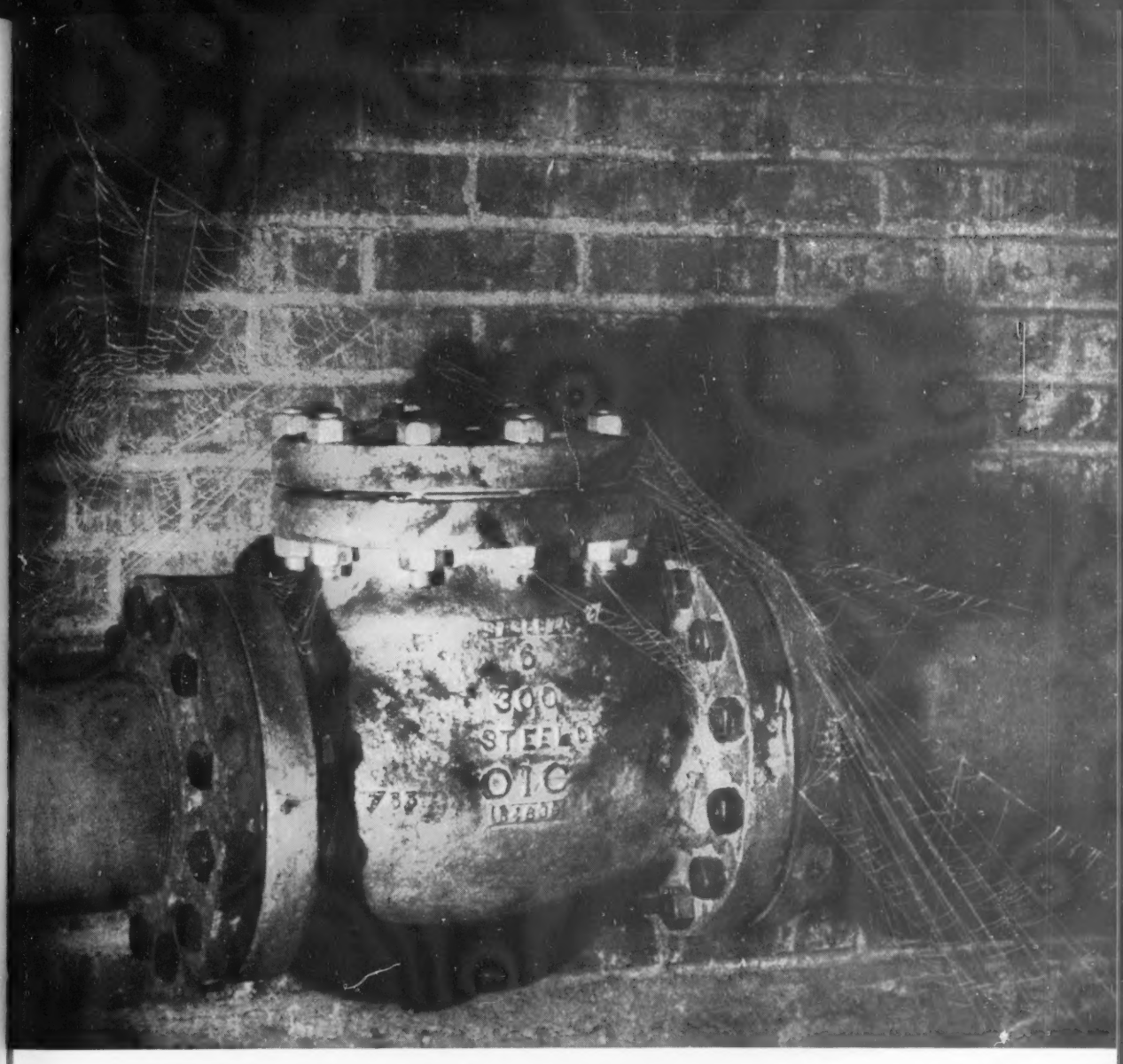

PORTRAIT OF DEPENDABILITY

Undisturbed cobwebs tell a powerful story! Day in and day out, OIC steel valves take strain, vibration, pressure changes and shock in their stride. From the outside you get no hint of the precise manufacturing tolerances that make this trouble-free performance possible. OIC steel valves are designed to handle your steam, chemicals or hydrocarbons with minimum maintenance and maximum cost savings. Of this you can be sure . . . OIC steel valves are built to operate with complete dependability.

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OIC VALVES

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The Ohio Injector Company 10818-OIC
263 Main Street, Wadsworth, Ohio
Your story interests me. Please send more information about valves used in my industry.

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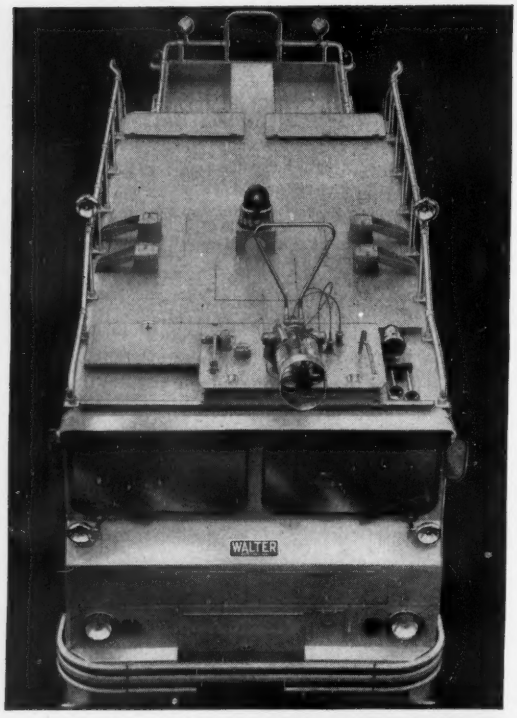

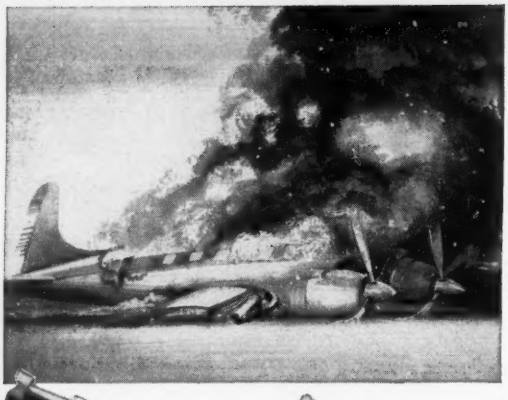

SPEED RESCUES AT CRASH FIRES!

Step up your department's life-saving power . . . equip with Rockwood FOAM systems, nozzles, FOAM liquid.

Rockwood equipment, selected for fast, flame-smothering rescue action at airport crash fires, brings the same powerful protection to municipalities, chemical plants, refineries and all industry. Rockwood makes the most complete line of turrets and nozzles, to handle solid FOAM stream, FogFOAM, WaterFOG and solid water stream. Make sure your own trucks are equipped for maximum safety of lives and property! For details on the complete Rockwood line write to Rockwood Sprinkler Company, Portable Fire Protection Department, 521 Harlow St., Worcester 5, Massachusetts.

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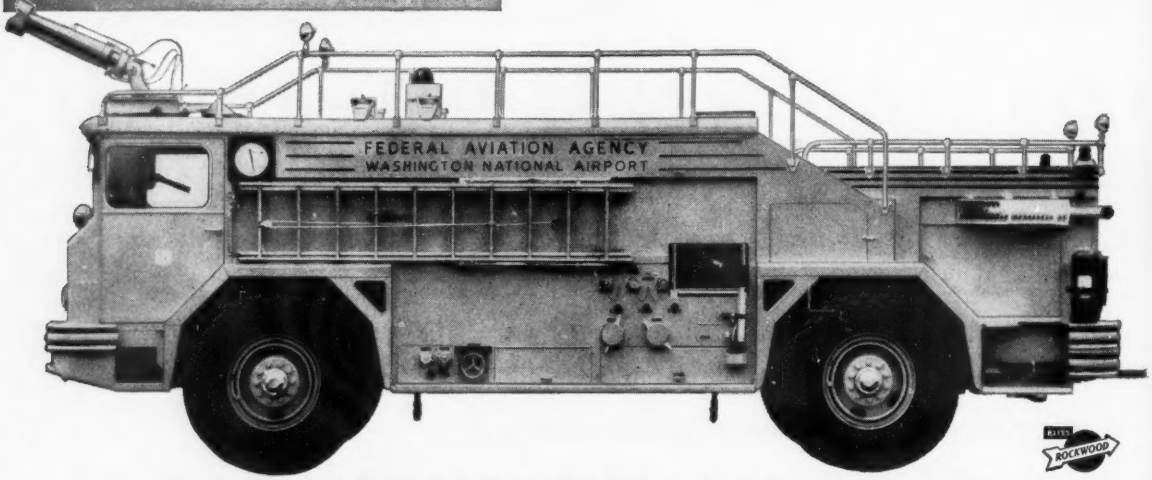
Engineers Water. . . to cut fire losses

Distributors in all principal cities



One of the largest, most effective Aircraft Rescue and Fire Fighting Vehicles is now in service at the Washington National Airport. Basic truck design is by the Walter Motor Truck Company. Fire fighting equipment specially designed by Rockwood includes: (1) 8000 GPM turret nozzle with hydraulic power control from within the cab or direct manual control from cab roof; (2) a ground sweep nozzle beneath the front bumper, which spreads a FOAM blanket to protect truck and crew; (3) nozzles for two handlines, discharging 600 GPM; (4) a FOAM proportioner for the pumping system. With Rockwood equipment, Rockwood FOAM liquid makes a powerful fire fighting combination.

. . . a new approach to boiler room profits

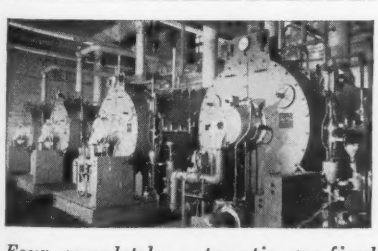
If you're faced with the decision whether to buy a new boiler or modernize your old one, consider these two basic facts:

1. Often, boilers can be modernized at a minimum of expense simply by installing a high-efficiency burner.
2. All packaged boilers do not operate with the same efficiency. You can't expect maximum return on your boiler investment if the boiler gives you efficiency only at certain firing rates.

A truly efficient boiler should operate at the same high efficiency at low capacity as at high or full load. *Powermaster* boilers are the *only* boilers that give you this constant, unchanging efficiency. This is 5 to 1 turndown efficiency. You get the same high efficiency at 20% of capacity as at 100%—and at every load in between, even when loads vary widely! This high efficiency means better boiler performance and impressive fuel savings that will repay the cost of your boiler many, many times in its long and productive life.

Powermaster boilers give you the fastest return on your investment . . . fewer man-hours to operate and maintain . . . more fuel and labor saving features than any packaged boiler on the market.

Need only a high-efficiency burner? O&S Burner Systems with 5 to 1 turndown are available for any make, size or design of boiler, watertube or firetube. Call your nearest O&S representative or write for Bulletin 1260.



Four completely automatic gas-fired Powermasters *in a large electric appliance plant replace a large coal-fired watertube boiler. Savings of over $10,000 a year are effected just in reduction of man-hours required for attendance. Operating advantages over previous boiler are impressive, with no variation of pressure over widely varying steam demands.*

Powermaster®

PACKAGED AUTOMATIC BOILERS

ORR & SEMBOWER, INC.

885 Morgantown Road

Reading, Penna. • Since 1885

New Tractor Shovel brings new economies to Swift & Co.

Michigan introduces Model 55B, early buyer likes its mobility, increased production capacity

5,400 lb lift capacity. Buckets from ¾ to 2 yds (1 yd standard). Turn radius, only 11′2″. Torque converter, power shift, power steer . . . these perhaps are the more important specifications of the new Michigan rear-wheel-steer Model 55B. Its main benefits: excellent maneuverability plus more capacity than previously available in its price class. Sales record to date: excellent. Example: Swift & Company's Plant Food Division.

Swift, we're proud to report, in just a few months has put Model 55B's to work in company plants in Wisconsin, Iowa, Texas, Louisiana, Georgia, North and South Carolina—in most cases alongside other Michigan models! Their experience in Madison, Wisconsin, is typical . . .

Turns in 11′2″

Here, Swift uses their 1 yd 55B with three other Michigans. A 16 cubic foot Model 12B Michigan unloads boxcars and feeds the raw material to bin conveyors. Raw storage bins to mixer, the material moves in the bucket of a 1¼ yd Model 75 Michigan. Transportation from mixed product bins to two shipping mill conveyors is the job of another Model 75 and the new Model 55B.

The 55B, with its 11′2″ turn radius, has been especially productive in locations where smaller bins and narrower aisles restrict maneuvering room.

300 ft cycle: 60 loads hourly

Pictures show the 66½ hp machine feeding 6-24-24 granulated fertilizer . . . one cubic yard, 1890 lbs per bucket load, 60 loads per hour. Average haul, 150 feet one way. All told, the four Michigans cover an area of 36,000 square feet, help make over 100 kinds of fertilizer, 95% of it bagged.

No lost time

Conditions provide a severe test of both men and machines. The air is very dusty. Material is abrasive and extremely corrosive. During the two or three month rush season machines must work 20 hours a day . . . full tilt all the time . . . hitting the piles hard, reversing fast, driving fast. Performance? The oldest Michigan, a Model 75 bought in February 1956, has in 12,000 working hours lost *virtually no assigned work time!* Efficiency has been equally good for the other three Michigans, including the year-old Model 55B. "Good, rugged units," is the way Swift's Madison plant manager summarizes it. "Our Michigans sure do a lot of work for us!"

Michigan is a registered trademark of
CLARK EQUIPMENT COMPANY
Construction Machinery Division

CLARK® EQUIPMENT

2477 Pipestone Road
Benton Harbor 25, Michigan

In Canada:
Canadian Clark, Ltd.
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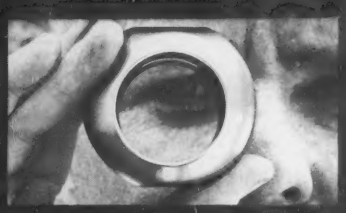
you can see the sense to

HILLS-McCANNA Ball Valve Design



McCannaseal® top-entry valves. Flanged-end models meet applicable API and ASA specifications. Patent applied for.

McCannaflo® valves of metal or heavy-duty PVC construction.

. . . the only ball valves available for service to 1000° F!

WEAR LIFE is remarkable because there is no metal-to-metal contact. The ball is cradled snugly between two non-metallic seats. No lubricant is required.

DIRT OR SCALE CAN'T PREVENT TIGHT SHUTOFF—the ball is wiped clean each time the valve is operated.

LEAKTIGHT STEM SEALING safely contains toxic, corrosive, or flammable fluids.

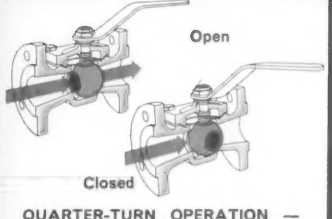
TWO-WAY SHUTOFF is provided by double seats. It doesn't matter which way the valve is installed in the line.

MINIMUM PRESSURE DROP because of the big, round, turbulence-free flow area through the ball. Smaller valves will do the job.

A COMPLETE LINE—1/4″ through 12″ . . . screwed, socket weld, or flanged ends . . . for temperatures from −150° to 1000° F . . . pressures from 10^{-6} mm Hg to 1000 psig.

ASK FOR NEW CATALOG No. 1200—complete specifications, temperature-pressure relationships, C_V values, dimensions, weights, materials, and service recommendations. You can select the valves you need directly from its pages. Send for your copy today.

PERFECT FOR AUTOMATIC AND REMOTE CONTROL— economical, compact, fast-acting, reliable—a complete line of air-operated valves for every job.



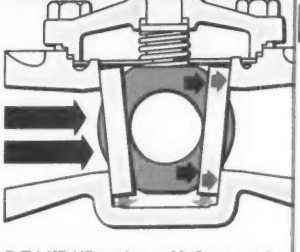
QUARTER-TURN OPERATION — When the hole in the ball is in line with the pipe, the valve is wide open. A quarter-turn closes it completely.

HILLS-McCANNA COMPANY

400 MAPLE AVENUE, CARPENTERSVILLE, ILLINOIS

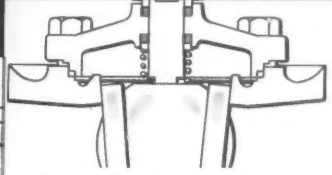
Valves and parts stocked nationwide by leading industrial distributors

What these valves really control is cost!



NO FLOW LEAKAGE—When the valve is shut off, line pressure forces the "floating" ball tightly against the downstream seat. The seat seals against the valve body. The higher the pressure, the tighter the closure.

AUTOMATIC WEAR TAKE-UP prolongs McCannaseal valve service life. As wear occurs, ball and seats are snugged down into "wedge" by corrosion-resistant, nonflexing, nontorsional spring.



STEM SEALING IS SOLVED—Two seals are maintained under constant compression by the stem nut which can be tightened to compensate for wear. The lower seal is back-seated so that line pressure works with it to prevent leakage.

you can see the sense to HILLS-McCANNA Diaphragm Valve Design

. . . now, with the most extensive line of lowest cost operators available!

When you look into a Hills-McCanna diaphragm valve, you immediately see that all of the working parts are sealed off by the tough resilient diaphragm which also serves to control the flow. Consider the operating advantages:

LEAKTIGHT SHUTOFF—even against solid particles which might lodge on the seat.

NO CONTAMINATION OF FLOW—especially important with foods, syrups, antibiotics, or any sanitary application.

PROTECTION of working parts against corrosive action of acids, alkalies, other materials.

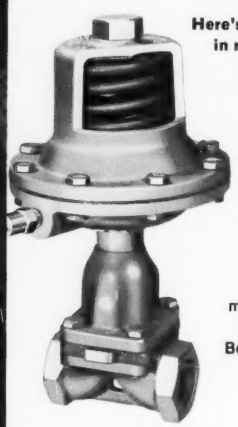
NO PACKING, hence no leakage around stem. Toxic, corrosive, and flammable fluids are safely contained.

SELF-CLEANING DESIGN, simple maintenance, excellent throttling control.

COMPLETE LINE—1/2" through 16" sizes—screwed, flanged, socket weld, and other end connections . . . pressures to 150 psig, temperatures to 400° F . . . more than 10,000 combinations of bodies, bonnet assemblies, and diaphragm materials to fit your service needs.

ASK FOR CATALOG No. 104 giving complete specifications and service recommendations.

SUPERIOR DIAPHRAGM DESIGN—patented sealing bead prevents leaks where others fail. Less closure force is required, longer life is insured. Available materials include reinforced elastomerics and solid plastics.



Here's real economy in remote control!

The low cost, high reliability, and compact size of Hills-McCanna air-operated diaphragm valves make them an outstanding buy for automatic and remote control service. Be sure to ask for Bulletin 134-A.

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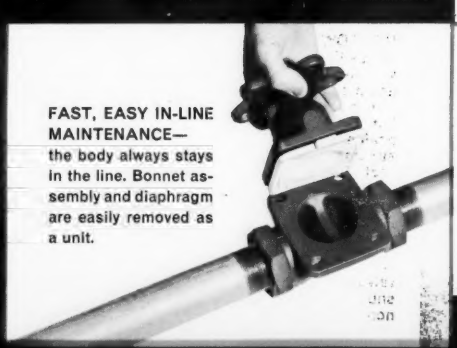
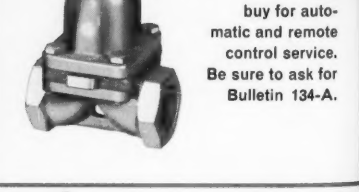
Valves and parts stocked nationwide by leading industrial distributors

What these valves really control is cost!



FAST, EASY IN-LINE MAINTENANCE—the body always stays in the line. Bonnet assembly and diaphragm are easily removed as a unit.



DOUBLE PROTECTION against leakage of hazardous fluids provided by outside stem and yoke or semisealed bonnets.

SUPERHOMO HOMOGENIZER MAKES COSMETIC CREAM SMOOTH AND EASY TO WEAR

Cherry-Burrell guards Lady Esther's quality

Lady Esther Dry Skin Cream and Hand and Body Lotion must be as smooth, as creamy, and as evenly textured as the skin it cares for. And the complexion — the nature — of Lady Esther creams is cared for by Cherry-Burrell homogenizers. They make sure it is evenly textured, intimately blended, and smooth enough to compliment the most delicate skin.

Cherry-Burrell homogenizers subject the cream to a strenuous shearing action. Explode it from 30 to 300 feet per second. And while increasing its velocity tenfold, change its direction abruptly 90°. The result: Lady Esther cosmetic creams and lotions that are so smooth and pleasant to use they generate repeat sales.

Highly trained technicians will test your product without obligation in a Cherry-Burrell laboratory. They will show you how Cherry-Burrell processing equipment can help you improve your operation and profit position. Your specialists are invited to participate in the testing. Call or write Cherry-Burrell today.

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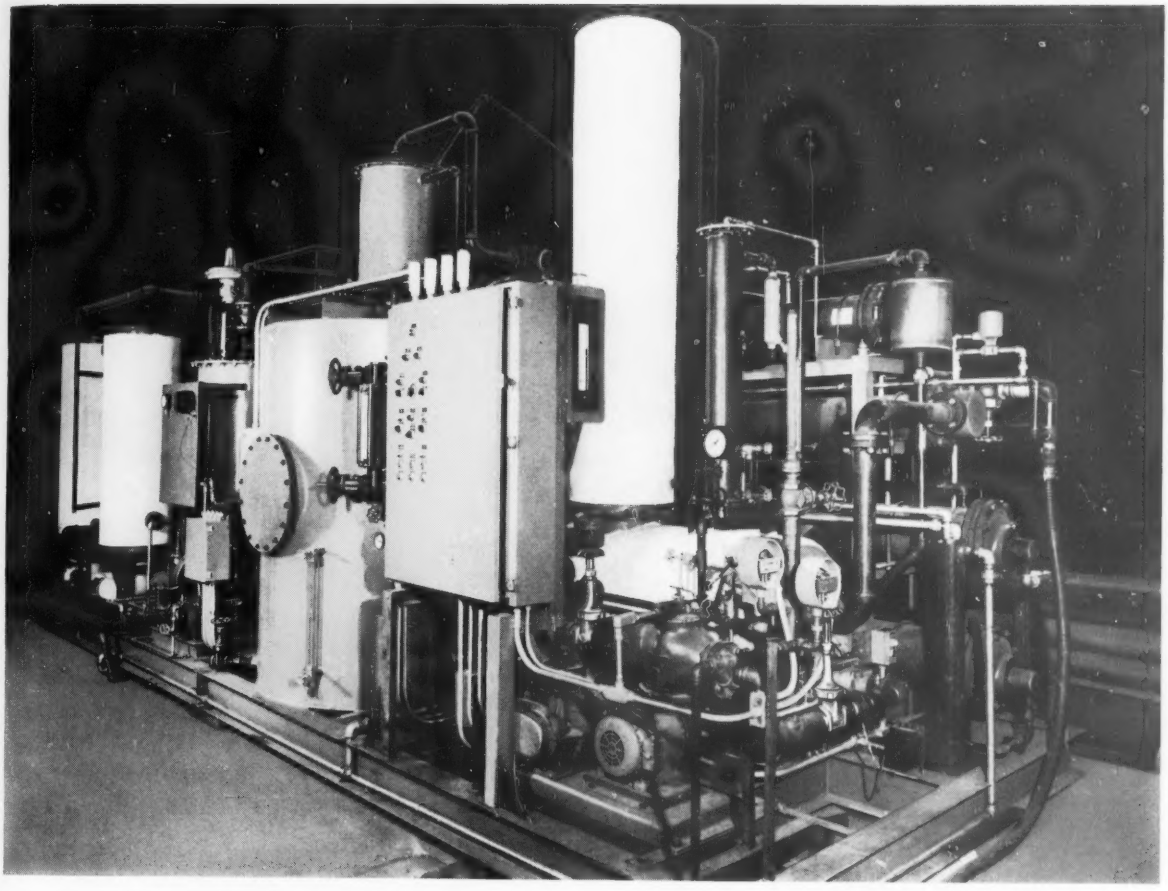

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Gas Atmospheres, Inc., Cleveland

"A reputation for reliability has made us the largest exclusive producer of packaged gas systems for industry. Care in choosing our components has helped build that reputation. We incorporate Jenkins Valves in our systems because our customers know there's nothing better to be had." Gas Atmospheres, Inc. of Cleveland and scores of other producers of industrial equipment employ Jenkins Valves to prevent trouble and costly maintenance for their customers. At the same time, they build respect for the quality of their products.

Of course, valves of less quality can be had for a little less money. But the real money-saving truth is that Jenkins Valves, so widely known for reliability and long life, COST NO MORE than any good valves. Jenkins Bros., 100 Park Avenue, New York 17.

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With the help of a Fairy Godmother, Cinderella had no difficulty finding a coach-and-four, footmen and even a husband. But today, with the help of Sinclair petrochemicals, manufacturers are creating products more wondrous than even Cinderella's Fairy Godmother could dream of.

For example, in the plastics and synthetic fibres industries, Sinclair petrochemicals are indispensable raw materials being used in the development of countless new and exciting products. Even when you add the new developments in paints, fertilizers, insecticides and detergents, you've only scratched the surface of profitable opportunities.

Sinclair supplies petrochemicals in both quality and quantity. Shipping and production schedules are set up to meet the most stringent demands. The purity of Sinclair petrochemicals sets industry standards.

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Chementator

U. S. equipment men have little to worry about from European imports

Among the 100,000 show-goers who swarmed over the Achema chemical exhibition grounds in Frankfurt, Germany, last month were two editors from *Chemical Engineering*.

Their report should gladden equipment manufacturers in this country: European equipment makers seem to have little interest in penetrating the U. S. market. One main reason is that the chemical industry in Europe is expanding so rapidly that European manufacturers have all they can do to supply their domestic demand.

Another reason is that although such items as pumps and compressors cost 20% less in Germany, freight charges to this country nearly cancel out any savings for U. S. customers. In addition, there is an 8-10 month delay in many deliveries.

On the other hand, some U. S. equipment companies are enjoying considerable success selling in Europe. One producer of homogenizers says, for example, that despite the higher cost of his equipment compared with European models, he can compete successfully because of shorter delivery times. A U. S. manufacturer of mixers and vibrators claims that not only can he undersell German manufacturers but he also can beat them on delivery time.

As a measure of the interest that some U. S exhibitors generated at Achema, one instrument company received 1,500 inquiries about a new line of gas density gages. And as a general rule, 75% of inquiries at Achema can be converted into sales.

First details released on process for flotation of beryllium ore

Taking an approach far different from Beryllium Corp. and United Technical Industries (*Chementator*, June 26, p. 53), Beryllium Resources, Inc., will soon start construction on a $2.5-million flotation mill at Delta, Utah, to produce 2 tons/day of beryllium concentrate by a novel flotation process.

Beryllium Resources disclosed some of the details of its process during a recent press showing of its pilot plant at Los Angeles. A flowsheet of the process will appear in the next issue of *CE*.

The beryllium fraction of the ore at Delta is extremely difficult to concentrate by flotation, a factor that has led other companies such as United Technical Industries to take the acid-leach approach. Main problem is the finely divided nature of the ore and its sliming tendency.

Beryllium Resources' method takes advantage of the amphoteric nature of beryllium and its ability to form chelates, creating water-repellent, air-attracting coatings on the tiny beryllium particles. Other minerals present are sequestered by forming water-soluble coatings on them. The reagents used to accomplish this are a tightly guarded secret; one chemical will even be manufactured by the company itself to avoid disclosing the composition.

After grinding and desliming, ore slurry goes through two rougher cells and six stages of flotation. Plant's final product is believed to contain 3-7% BeO.

Gas-poor Britain may import large tonnages of liquefied methane

Liquid methane, produced in North Africa and shipped in low-temperature tankers, may be the answer to Britain's perennially tight supply of natural and manufactured gas. Up for approval by British and French governmental agencies is a plan submitted by Conch International Methane, Ltd., the Gas Council of Great Britain and a group of French companies, for the importation of Sahara Desert gas into the United Kingdom. (Conch is owned by Continental Oil Co., Royal Dutch Shell, and the Union Stockyard and Transit Co.)

Under the plan, 770,000 tons/yr. (about 10-15% of U. K. fuel demand) of methane would be liquefied at Arzew, near Oran, and carried to England by two British-built tankers. Impetus

LIGHT

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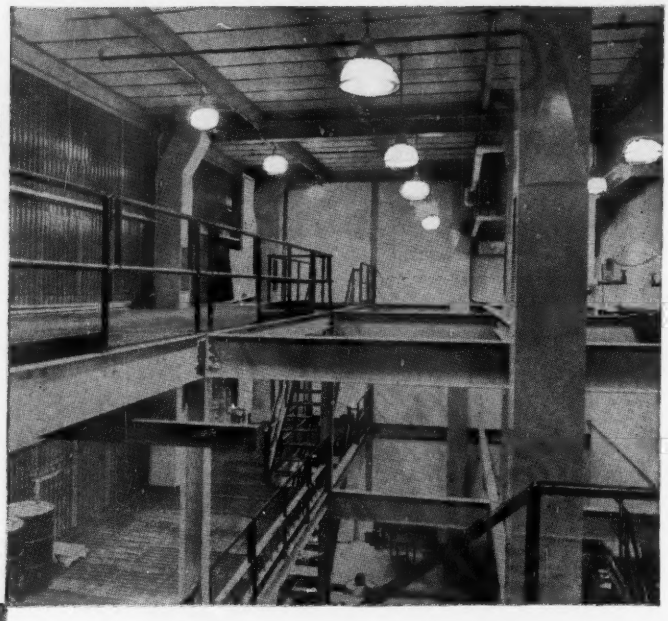
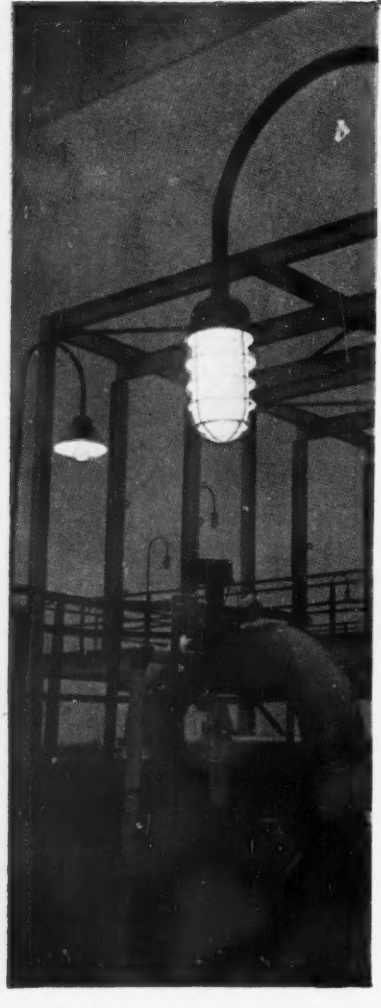


Crouse-Hinds Explosion-Proof Lighting Fixtures in Class I, Group D location



Crouse-Hinds Vaportight Lighting Fixtures in a corrosive outdoor location

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When there's something in the air – explosive gases, ignitible dusts, corrosive fumes – Crouse-Hinds has exactly the light to give you lighting exactly where you need it – with complete safety!

Lighting that's safe to operate in explosive concentrations of acetylene . . . hydrogen . . . gasoline vapors . . . organic, inorganic or metallic dusts. Lighting that stands up under the corrosive attack of acids, salts, alkalis.

What *kind* of lighting do you need: Bench . . . area . . . flood? Incandescent . . . fluorescent . . . mercury vapor? Permanent . . . portable?

You'll find them all in the Crouse-Hinds catalog. It's the *only* place you'll find lighting for every Class and Group under the National Electrical Code.

Ask your Crouse-Hinds Distributor.

Crouse-Hinds Dust-Ignition-Proof Lighting Fixtures in grain elevator — a Class II, Group G location

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for the plan was furnished by the success of the tanker *Methane Pioneer*, which last year completed its seventh voyage carrying liquid methane from Lake Charles, La., to London.

Concurrently, Britain's National Coal Board has been seeking to show that municipal gas could be made from coal more cheaply than by importing methane, providing that bigger gasification plants (over 1 million tons/yr.) were built. Britain's first Lurgi pressure-gasification plant, now on stream at Westfield, Scotland, will soon be producing 30 million cu. ft./day of 400-Btu. gas.

The *Methane Pioneer*, being too small for commercial liquid methane service, is now making more transportation history. It will be one of two refrigerated tankers carrying liquid butadiene to Texas Butadiene & Chemical International's refrigerated terminal now under construction near Rotterdam, Holland.

Process for solvent-seasoning California redwood has been developed at University of California. Green wood is placed in vapor-tight chamber, is then sprayed with recirculating acetone at 130 F. Process achieves equivalent of months of seasoning in eight days, also extracts chemical byproducts such as tannin that can be recovered from the acetone.

Compressor failure pinpointed as cause of latest oxygen plant blast

A recent explosion in the oxygen plant at Great Lakes Steel Corp. in Ecorse, Mich., has been blamed on a faulty compressor. The blast, which occurred on June 21, killed three operators.

Plant was built and operated by Linde Co., division of Union Carbide. A full investigation is now under way, but the results probably won't be known for several months. It's believed that the explosion occurred in the second stage of a three-stage reciprocating compressor. The machine was used to shunt gaseous oxygen to outside storage vessels when the steel mill was not drawing oxygen from the plant.

This explosion is evidence of what some observers see as an increasingly serious problem in air plant operation. The Factory Insurance Assn., which underwrites many chemical plant insurance policies, says that it has paid $300,000-$400,000 to cover losses from about a dozen air-plant compressor fires in the past three or four years.

Compressor fires are usually less destructive —but more frequent—than explosions in the distillation or condensing sections, which are usually caused by accumulated hydrocarbons. Typical of the latter trouble was the explosion last year that injured 12 workers at Du Pont's Belle, W. Va., works.

Compressor failures are growing at a rate greater than the increase in oxygen plants, says Factory Insurance. It blames this primarily on the increasing size of the plants. Compressing larger volumes of product oxygen, at pressures approaching 100 psi., creates hazardous conditions that could be more easily handled with smaller equipment. Also, handling greater volumes of intake air increases the input of hydrocarbon impurities.

Acetonitrile recovers butadiene from C_4 saturate-olefin mixture

As part of the growing interest in polybutadiene rubber, many companies are looking at new ways to produce polymerization-grade butadiene. The latest process to win commercial endorsement is Shell Development's extractive distillation process employing acetonitrile.

Polymer Corp., Ltd., has licensed Shell's route for use in a $1.5-million high-purity butadiene unit to be built at Sarnia, Ont. This will mark the first use of the acetonitrile process outside a Shell plant. Fluor Corp. of Canada will handle engineering and construction of the unit, which is scheduled to come on stream late this year.

Technique of using acetonitrile was developed by Shell at its Torrance, Calif., plant (*Chem. Eng.*, Feb. 1957, p. 146). That unit, however, recovers mixed butylenes from a saturate-olefin mixture. Basic process can be modified to recover high-purity butadiene from a mixture of saturates and mono- and diolefins by adding a purification column to the proven flowsheet for removal of residual olefins.

Process works like this: mixed C_4 saturate-olefin stream (e.g., product from a butane dehydrogenation unit) is vaporized and fed to the middle of the main extraction column, where it contacts acetonitrile containing up to 10% (by

(Continued on page 60)

AT LAKESIDE LABORATORIES, IN
P-K VACUUM TUMBLE DRYER IM
PRODUCT UNIFORMITY...
LOWERS LABOR COSTS...
REDUCES DRYING TI

Lakeside Laboratories, Inc., a Milwaukee manufacturer of ethical pharmaceuticals, has replaced conventional tray drying with a P-K Vacuum Tumble Dryer. The pre-packaged 20 cu.-ft., stainless steel unit arrived fully engineered, ready for start-up. "It had everything we wanted—a hot water jacket vacuum pump, condenser, condensate receiver, vacuum control valve, water heater and circulating pump—and was reasonable in cost," explains Joseph Jacques, plant engineer.

Today, all products Lakeside manufactures in quantity are processed in the P-K unit. "It has made it possible for us to reduce drying time as much as two-thirds and cut labor costs in half," says Mr. Jacques. "It used to take 48 hours to dry a batch of material we're now able to prepare in 16 hours. Handling time is a fraction of what it was and the resultant blend is more uniform in texture and color. Furthermore, moisture content of products can be reduced to as low as 1/10 of 1% in the vacuum tumble dryer.

"Cleaning, too, is faster and easier, thus facilitating formulation change-over without time loss. After each use, the dryer is filled with water, rotated and flushed. There's never any residue and reduced handling also reduces chances for contamination."

ONLY P-K OFFERS COMPLETELY PRE-PACKAGED VACUUM TUMBLE DRYERS Packaged vacuum tumble drying equipment—tailored to individual requirements

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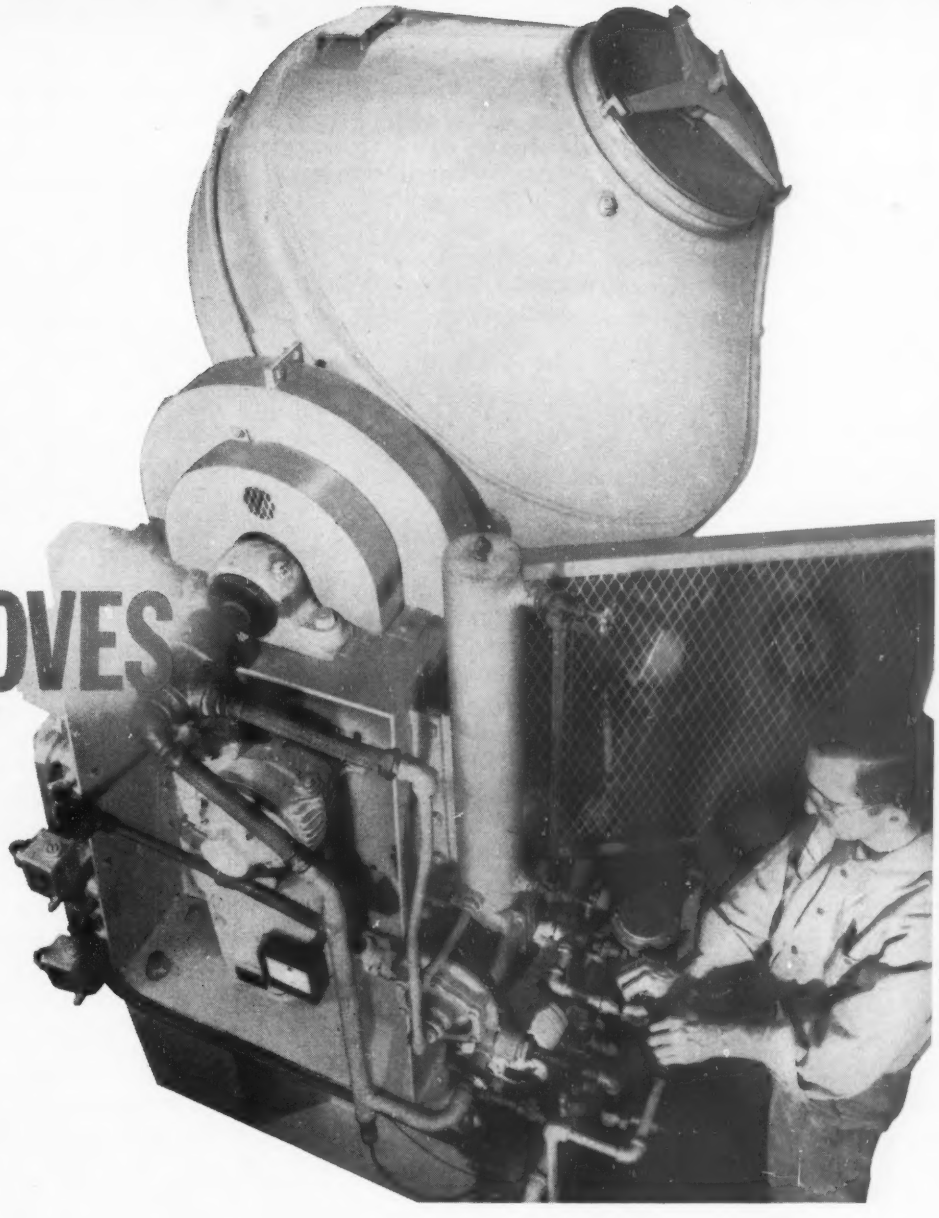

and thoroughly proved in performance—is available only from Patterson-Kelley. It is delivered compactly assembled, fully balanced and ready for use. Yet, costs are far less than user-assembled units. In addition, it provides a single source of responsibility. In every step from design through start-up, it saves time—eliminates trial and error expense.

PRE-TEST BEFORE YOU BUY Visit the P-K PRE-TEST LABORATORY for a preview of the economies *you* can realize with a packaged vacuum tumble dryer. P-K engineers have run thousands of resultful pre-tests for processors. They justify investment, provide accurate scale-up data and operational procedures. Production models of standard, intensifier and liquid-solids Twin-Shell* blenders are available, as well as packaged vacuum tumble dryers. Our new P-K Solids Processor that telescopes up to ten operations in a single unit is also featured in the Pre-test Laboratory.

Send us your materials, if you can't come in person. To make arrangements, write or call George Sweitzer at East Stroudsburg. Dial 717—Hamilton 1-7500.

Our new Solids-Process Catalog #16-P contains complete technical information on P-K equipment. We'll gladly send you a copy.

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Patterson Kelley

Chemical and Process Equipment Division
124 Burson St., East Stroudsburg, Pa.

weight) water. Olefins leave in the solvent from the bottom of the column, pass to a stripper that produces a crude butadiene product overhead. Final purification column yields butadiene over 98% pure.

Although no operating data have been revealed, Shell claims that its process is more economical than older extractive distillation processes (which use furfural or acetone) or the copper ammonium acetate extraction process.

Chance Vought Aircraft, Dallas, has launched a detailed design program for a sea water distillation plant that would use powdered or pelletized radioactive wastes as a heat source. Preliminary studies indicate that fresh water could be produced for under $1/1,000 gal. in a 1-million-gal./day plant.

Investigators blame contractor for nuclear reactor disaster

The report issued by the board of investigation looking into the SL-1 reactor explosion at Idaho Falls, Idaho, (*Chementator*, Jan. 23, p. 74) has placed primary responsibility for the incident on Combustion Engineering, Inc. The firm was operating the reactor under contract to the Atomic Energy Commission.

Although the exact cause of the explosion is not known, the report states that "before the incident occurred, the condition of the reactor core and reactor control system had deteriorated to such an extent that a prudent operator would not have allowed operation of the reactor to continue." The report also criticizes the AEC for not ensuring that its contractor was following adequate safety procedures.

Probable source of trouble in the reactor was the aluminum-boron-nickel alloy strips that had been spot-welded to the control rods to provide extra moderating capacity. These strips began to flake off as they aged, decreasing the moderating potential. In addition, pronounced bowing of the strips caused the control rods to stick 40 times in the two months prior to the incident.

Just before the explosion, the control rods were arranged so that a chain reaction could start by lifting only one rod. The final control rod might have been lifted by what would normally have been a safe distance, but having less than the usual moderating ability, it may have been enough to cause the nuclear excursion that killed the three operators.

Texaco will soon start up an unannounced hydrocracking installation at its Los Angeles oil refinery. Emphasizing the current interest in hydrocracking (Chem. Eng., May 1, p. 38), the multimillion-dollar plant will employ a new process developed by Texaco.

Production under way on alkylated phenol that yields flexible resins

Phenolic resins, having lost markets to thermoplastic materials possessing more flexibility, may now spring back into contention.

Internally plasticized phenolic resins, which are much more flexible than conventional phenolics, can be made with Flexiphen 160, an alkylated phenol now available in tank car lots from the Tar Products Div. of Koppers Co., Inc.

Produced at Wyandotte, Mich., Flexiphen is a polymethylene polyphenol. It is produced under a licensing agreement with General Electric Co., costs about twice as much as ordinary phenol. Benefits of Flexiphen accrue largely to processors who use phenolic resins in molding applications. Improved preheating properties reduce premature gelation; lower specific gravity increases output of articles per pound of resin by 5%. Most important, industrial laminates formed from the new phenolics have almost 30% higher flexural strength than conventional resins, and possess good cold-punching properties.

Flexiphen is made by alkylating phenol or mixture of phenols with chlorinated hydrocarbon chains, using an aluminum chloride catalyst. The chains, containing approximately 25 carbon atoms, overcome the normally brittle cure of phenolic resins by providing less-rigid intermolecular bonds, permitting resin molecules to flex and bend while retaining the other desirable properties of conventionally plasticized phenolics.

One disadvantage is still to be overcome. Resins produced from Flexiphen are dark in

color, thus they cannot be used for applications where pastel color-appeal is desirable.

A solid-fueled rocket, with "highest over-all performance" of any solid-fuel system, has been announced by United Technology Corp., Sunnyvale, Calif. Main improvements are weight reductions in the glass fiber casing, new lightweight rubber-like insulator, plus a propellant configuration that further reduces insulation requirements.

Court finds, on the facts, that Canadian engineer owns know-how

A Canadian engineer last month won a first-round court battle with his former employer. At issue: whether he was using his own know-how to practice engineering for a competitor or whether he had improperly taken and used plans or specifications of the ex-employer.

In dismissing Electric Reduction Co.'s four-year injunction against its former chief engineer, George J. Crane, the Ontario Supreme Court noted that "not a tittle of evidence" was provided by the firm to back its claim of misappropriated documents.

Although the company in its original claims has sought to prevent Crane from using its trade secrets, the legal action centered on whether or not he had taken company documents. Thus, the more nebulous question of who owns an engineer's knowledge (*Chem. Eng.*, July 28, 1958, p. 127) was avoided. But in finding that Crane hadn't taken any papers, the court left him free to use any know-how he now carries in his head.

Crane showed that while chief engineer of the firm he had borrowed a complete set of drawings of a sodium chlorate plant under construction in late 1956. But after familiarizing himself with their details in order to remedy on-site trouble, he destroyed the 640 prints.

A few months later, Crane answered a recruitment ad of Huron Chemical Co., gave an Electric Reduction director as a reference. In June 1957, Electric Reduction dismissed the engineer, and in August the firm obtained an interlocutory injunction, effectively barring Crane from practicing sodium chlorate technology for his new employer or for others.

Crane filed a counterclaim for wrongful dismissal and, in finding against Electric Reduction, the court allowed him $7,500—half of what he had asked. Since Huron's financial backing collapsed because of the injunction, the court has also referred the matter to a Master (court-appointed referee) to determine if any damages have accrued as a result of the injunction.

Electric Reduction has appealed the judgment, and further action (perhaps late this year) will await the outcome of this appeal.

Latest available phthalic process spurs interest in ortho-xylene

Badger Mfg. Co. recently concluded a licensing agreement with California Research Corp. under which Badger will build phthalic anhydride plants using the Cal Research process. This is basically the same vapor-phase, *o*-xylene-based process that Oronite Chemical has been using for 15 years at Richmond, Calif.

First to buy the process is England's Grange Chemical, Ltd. Badger's British affiliate will build a 33-million-lb./yr. phthalic plant for Grange adjacent to Distillers Co.'s facility at Hull, Yorkshire.

Badger thus becomes the second U. S. firm (the first was Scientific Design) that is now promoting *o*-xylene as a phthalic feedstock. In the past, the material was considered a poor substitute for naphthalene because of lower yields and reduced plant throughputs. But developments in catalysts and engineering design have made *o*-xylene a much stronger contender (*Chem. Eng.*, May 29, p. 48).

Key to acceptance of *o*-xylene as a primary feedstock on the part of phthalic makers now depends on the price structure that is established. Recently, Enjay Chemical has been offering *o*-xylene supply contracts with a clause that keeps the price lower than naphthalene. This differential (size not revealed by Enjay) will influence the inroads of *o*-xylene on the naphthalene market.

Another factor to consider is steel. As business picks up, there will be more byproduct naphthalene coming from the coke ovens. So there could be a three-way price war brewing between *o*-xylene, coke-oven naphthalene and petrochemical naphthalene.

For More Industry & Economics News . . . p. 64

Excitement... about a new chemical fresh from Research and Development!

B&A® SULFAMIDE

Recently, one of our ads went on a "fishing expedition" to explore possible uses for a number of new chemicals. *Among them was B&A Sulfamide.* So much interest was expressed in Sulfamide that we are taking this opportunity to tell you more about it.

B&A Sulfamide is similar to urea in many of its reactions, except that it is more acidic, and can act as a dibasic acid. Here are twelve properties and reactions of this interesting new chemical. Do they give you some ideas of your own?

Nitration

$NH_2SO_2NH_2 + HNO_3 \longrightarrow NH_2SO_2NHNO_2 + H_2O$

Chlorination

$NH_2SO_2NH_2 + HOCl \longrightarrow NH_2SO_2NHCl + H_2O$

Salt Formation

$NH_2SO_2NH_2 + 2NaOH \longrightarrow NaNHSO_2NHNa + 2H_2O$

Various mono- and di-metallic salts have been made.

Heat

$NH_2SO_2NH_2 \longrightarrow NH_2(SO_2NH)_xSO_2NH_2 + (SO_2NH)_3 + NH_3$

Hydrolysis

$NH_2SO_2NH_2 + H_2O \longrightarrow NH_2SO_3NH_4 \xrightarrow{H_2O} (NH_4)_2SO_4$

Sulfamide is stable in dilute acid or alkaline solution.

PCl_5

$NH_2SO_2NH_2 + 2PCl_5 \longrightarrow SO_2(N{:}PCl_3)_2 + 4HCl$

Alcohols

$NH_2SO_2NH_2 + 2ROH \longrightarrow R_2O + NH_2SO_3NH_4$

Sulfamide is a strong dehydrating agent under some conditions.

Organic Acids

$NH_2SO_2NH_2 + RCOOH \xrightarrow{\text{Pyridine}} RCONH_2 + ?$

Amines

$NH_2SO_2NH_2 + RNH_2 \longrightarrow NH_2SO_2NHR \xrightarrow{RNH_2} RNHSO_2NHR + NH_3$

Primary and some secondary amines react thus.

Acylating Agents

$NH_2SO_2NH_2 + RCOCl \longrightarrow RCONHSO_2NH_2 \xrightarrow{RCOCl} RCONHSO_2NHCOR + HCl$

Acid anhydrides react similarly.

Aldehydes

$NH_2SO_2NH_2 + C_6H_5CHO \longrightarrow NH_2SO_2N{:}CHC_6H_5 + H_2O$

Other aldehydes may form methylols or resins, depending on conditions.

Isocyanates

$NH_2SO_2NH_2 + RNCO \xrightarrow{\text{Base}} NH_2SO_2NHCONHR$

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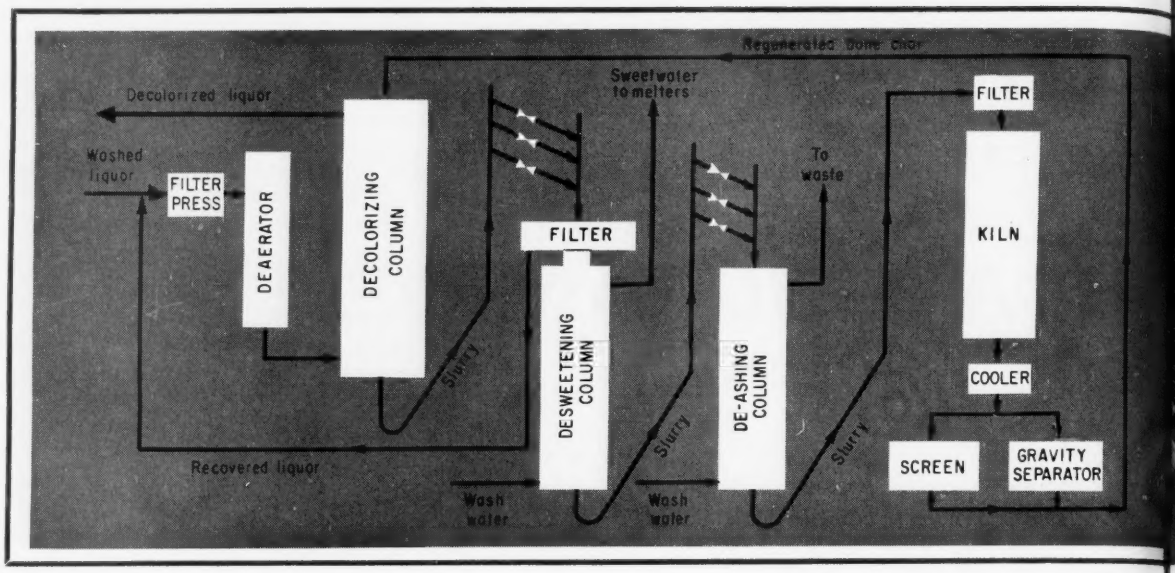


MODERN ADSORPTION HEADS LIST OF NEW TECHNIQUES

American Sugar's ultramodern facility, first to employ an automated decolorizing system, reaps benefits from low initial and operating costs, higher quality.

Now on stream at The American Sugar Refining Co.'s new 2,000,000-lb./day Bunker Hill (Boston) refinery is the first plant-scale installation of the company's patented (U.S. 2,954,305) continuous adsorption process (CAP) for decolorizing cane sugar liquor.

According to company officials, the equipment has met the major objectives of providing a continuous, low-cost, automated purification step.

Compared with a conventional char cistern system, CAP has effected direct savings, exceeding:

- 50% in capital investment.
- 90% in operating costs.
- 50% in fuel for bone char reactivation.
- 75% in char inventory.
- 80% of in-process sugar liquor inventory.

In other areas of the refinery, it has: reduced char usage, improved product quality, increased sugar extraction, cut recycling of sugar liquors and sweet water; minimized remelt boilings; eased refining of difficult raw sugars and promoted sanitation.

▶ **3-Column Decolorizer** — System has been piloted since 1957, initially with a 6-in.-dia. decolorizing column, later with a 4-ft.-dia. column having a 27-ft.-deep char bed and auxiliary equipment for desweetening, de-ashing and reactivating the char. The commercial system comprises: three 12-ft.-dia. decolorizing columns, each with a 40-ft.-deep bed of bone char adsorbent; one 3½-ft.-dia. desweetening column, one 3½-ft.-dia. de-ashing column.

In the CAP system, unlike conventional stationary-bed char-cistern operations, both adsorbent and sugar liquor move. The liquor travels upward at a uniform rate, while the adsorbent moves downward at a much slower rate.

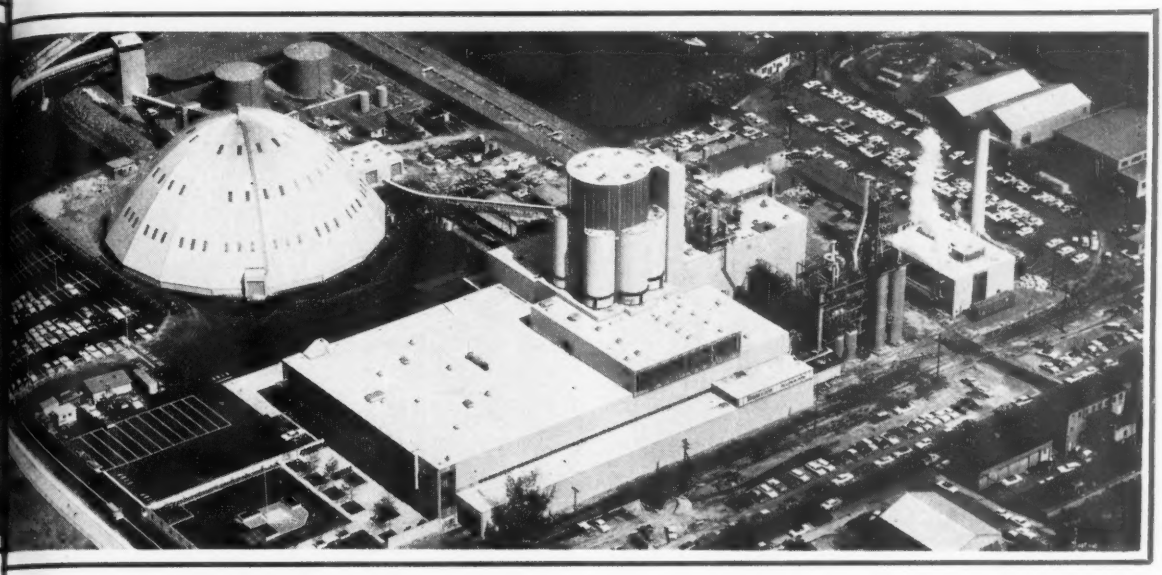
In order to utilize the adsorbent capacity of the char to the fullest extent, the particles are separated very slightly by upward velocity of the liquor, thus allowing the adsorbent surfaces to be in intimate contact with the sugar liquor.

This condition can be visualized as being part way between the packed bed of a conventional char cistern and the fluidized bed used in many oil refinery catalytic processes. The expanded bed also prevents channeling or bypassing of liquor.

The continuous countercurrent nature of the operation contributes further to the success of the new system. Char with the highest adsorptive capacity contacts liquor with the lowest level of impurities, and the partially exhausted char contacts the liquor with the most impurities, thus taking advantage of favorable diffusion and adsorption equilibria.

▶ **Liquor, Char Feed Systems**—To insure maximum utilization of the adsorbent bed over its entire cross-sectional area, feed liquor is introduced near the bottom of the decolorizing column through a carefully designed system of evenly spaced sparger feed pipes connected to a common manifold.

Space between these pipes allows downward movement of the char bed. Facing downward on each



THAT SPAN QUARTER-CENTURY GAP IN SUGAR REFINING

branch pipe is a row of evenly spaced orifices that admit liquor at low pressure. About 85% of this liquor moves upward through the char bed, while the other 15% flows downward.

The upward flowing liquor is decolorized and drawn off the top of the column by a hexagonal trough, so designed as to remove an equal quantity of liquor per unit area.

Regenerated bone char is fed to the top of the column through a pipe having a series of slots at its lower end. A sliding sleeve provides a gate for the slots. The gate is raised or lowered to control flow into the feed chamber and down into the soaking tubes.

These tubes extend into the decolorized sugar liquor so that the dry char will be freed of air and wet with liquor before falling onto the bed of adsorbent (Fig. 1). Tubes are spaced to provide equal char feed per unit area of column.

Spent char is discharged continuously from the bottom of the column in the form of a slurry along with the downflowing 15% of the sugar liquor feed. Below the feed liquor injection point, column shape is conical and the bottom is rounded. An inverted cone with apex at column's center directs slurry flow equally per unit area into four compartments (Fig 2). At bottom of each compartment is a drop-out pipe that extends downward below bottom of column.

From here, a gooseneck conducts the slurry into a conical collector. Hydraulic head in the column forces slurry through this collector and up a lift pipe to a series of cross-over pipes at different heights below the liquid level in the column. By selecting the desired pipe, the operator can control slurry flow rate and, in turn, depth of the char bed in the decolorizing column.

► **Desweetening**—Slurry from the decolorizer is filtered on a top-feed rotary vacuum screen to separate carrier liquor from char. Recovered liquor is returned to decolorizer feed stream. Char drops through the single soaking tube of the desweetening column where it meets an upward flowing stream of hot water. Water inlet spargers near bottom of column and the sweetwater removal system at top are similar to those in decolorizing column.

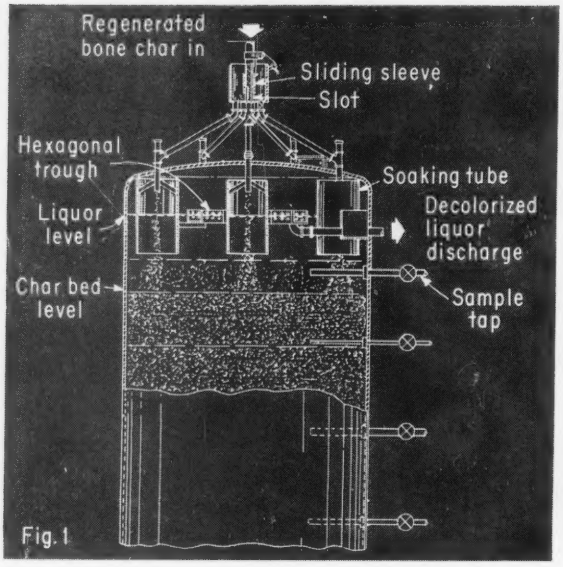
Since the rate of desweetening is very rapid, only one column is required to handle all of the char from three decolorizing columns.

Desweetening is accomplished with a minimum of water, the ratio of water to char being about 1:2 by volume. A continuous flow of high-purity sweetwater of about 30 Brix is produced.

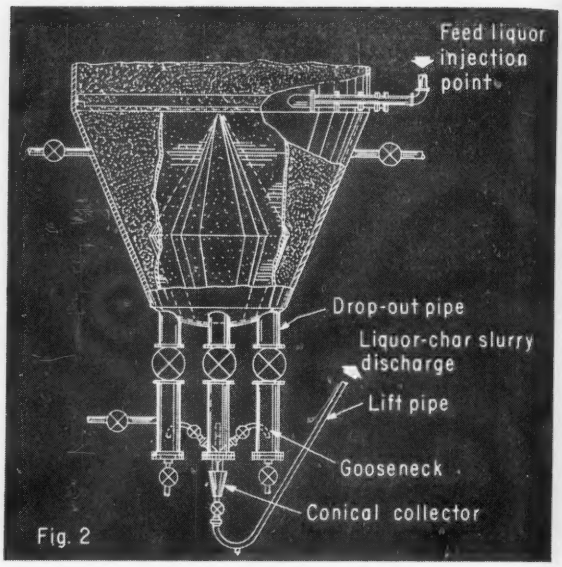
Spent char is discharged from the desweetening column as a slurry, and fed to the top of the de-ashing column without dewatering. Char bed height is determined and controlled by methods similar to those used in the decolorizing column.

► **De-Ashing and Reactivating**—The de-ashing column is of the same size, design and construction as the desweetening one and is operated similarly. Wash water enters near the bottom and passes up through the char, removing adsorbed organic and inorganic impurities.

The char slurry discharged from bottom of column goes to a top-feed rotary vacuum dewatering screen where, by suction and hot air drying, moisture content of char is reduced below 20%.



At top of decolorizing column, regenerated char is evenly distributed by means of soaking tubes. Sugar liquor is removed through hexagonal trough.



At bottom of column, an inverted cone directs flow of spent char-liquor slurry into four drop-out pipes. It then goes to a collector and to desweetening column.

Dewatered char is fed to top of a multiple-hearth kiln where it is reactivated in a low-oxygen atmosphere. The char is cooled, screened and conveyed to top of decolorizing column, thus completing the adsorbent loop of the process.

► **Remotely Controlled** — Primary control of the system is by instrumentation in the refinery central control room, 300 ft. from the outdoor CAP system. Controls for liquor and water flow rates, bed levels and kiln are all located here, as well as recorders for oxygen content of flue gases, total adsorbent flow, sweet water production.

Some of these controls are duplicated at the CAP site. In addition, such information as bed levels, kiln hearth temperature and flow rates are recorded or indicated here.

An area operator is available to make, on call from the control room operator, minor adjustments on the kiln or other CAP equipment. Experience has shown that about one-half of this operator's time is required for such attention.

The CAP system has such flexibility that any desired color removal can be obtained. No liquor blending is required, thus no liquor gallery is needed.

The system is effective in removal of ash from either untreated or pretreated washed sugar solutions. In both pilot-plant and commercial operations, 45-50% of the ash present in the liquor feed was adsorbed. Included were essentially all of the calcium and sulfate ions, and about two-thirds of the magnesium ions. Sodium and potassium ions were only slightly adsorbed.

Practically no desorption of these ions has been experienced in the commercial desweetening unit. This results in a char sweetwater of exceptionally high purity that is used directly for melting washed raw sugar.

► **Other Advances, Too**—The new refinery, first to be built in the U. S. in more than 25 years, is the culmination of intensive study and experimentation.

Raw sugar is received in bulk, primarily from the company's 9,500-ton self-discharging motor ship "Domino Crystal," and conveyed to the special 30,000-long ton parabolic storage warehouse.

All refining steps other than the adsorption process are housed in the refining center. The layout here utilizes gravity flow to minimize piping and conveying lines. Similar types of equipment are grouped together to maximize labor efficiency. Units were designed and installed to make sanitation easy.

Adjacent but connecting buildings provide areas for refined-sugar storage, packaging, warehousing and shipping, and liquid sugar storage and shipping. Raw-sugar storage and steam and power generation facilities are in separate buildings.

Heart of the refining complex is the central control room, which contains graphic panels showing process flow and equipment operation from the raw-sugar warehouse to refined-sugar screening. In addition to indicator lights for pumps, conveyors and similar units, cycle and shutdown alarms for major items are located here. Indicating-controlling instruments for such critical process variables as solids content, flow rate, pH and temperature, and for complete process steps such as decolorizing and pan boiling, are located here.

A data logger receives and records data from over 200 points in the refining process. In addition, it signals off-normal conditions.

A separate instrument control panel is provided for the mechanical filtration, screening and bulk storage stations.—AVG

FINALISTS FOR 1961 KIRKPATRICK AWARD

Ashland Oil	Production of naphthalene from petroleum
Continental Oil	Synthesis of straight-chain primary alcohols
Linde	Development of synthetic zeolite selective adsorbents
Monsanto Chemical	Application of computers to process control
Texaco and Thompson Ramo Wooldridge	First on-line digital computer control of an industrial process

PETROCHEMICAL DEVELOPMENTS VIE FOR AWARD

Winner of Award for Chemical Engineering Achievement will be chosen from among the top five picked by Award Committee.

Preliminary judging of fifteen entries for the 1961 Kirkpatrick Award for Chemical Engineering Achievement has narrowed the field to the top five nominees listed above. From this group will come the final winner, to be honored on November 28 at the Award Dinner sponsored by *Chemical Engineering*.

Finalists were chosen by department heads of the 99 AIChE-accredited chemical engineering schools in the U. S. on the basis of 500-word briefs describing each achievement being judged. Competition was keen; among the top five (listed above alphabetically), only five votes separated first from fifth place, and only two votes separated fifth from sixth.

▶ **Petrochemicals Dominate** — Although the original fifteen entries covered a broad range of chemical process industries (plastics, metals, etc.), the five finalists all represent the field of petrochemicals. Ashland and Continental were chosen on the basis of petrochemical process developments; Texaco's computer application was to a polymer gasoline unit, Monsanto's to an ammonia-from-natural-gas plant; and Linde's synthetic zeolites have found their widest applications in the drying, purification and separation of hydrocarbons.

Three of these companies have won or shared previous *Chemical Engineering* Achievement Awards. Most recent was Texaco, whose development of the partial-oxidation synthesis gas process took the honors in 1959. Texaco also shared in the 1943 award to the American synthetic rubber industry. Monsanto was cited back in 1937 for its pioneering work on elemental phosphorus; the company also shared in the awards to the rubber industry and (in 1946) to the atomic bomb project. Linde, a division of Union Carbide, participated in the A-bomb award; other divisions of Carbide won or shared awards in 1933, 1943, 1946, 1953 and 1957.

▶ **Picking the Winner** — Final selection of the 1961 winner will be based on the following newly revised definition of the award:

The Kirkpatrick Award for Chemical Engineering Achievement recognizes an outstanding technological accomplishment achieved through the group effort of chemical engineers. It is awarded to a company, to a department within a company, or to a group of companies, rather than to any individual. Criteria for judging the achievement are the difficulty of chemical engineering problems encountered and solved, novelty of the technology and evidence of commercial success.

Responsibility for this year's selection lies with this Board of Judge: M. S. Peters, University of Illinois, Chairman; N. R. Amundson, University of Minnesota; A. S. Foust, Lehigh University; E. R. Gilliland, Massachusetts Institute of Technology; D. L. Katz, University of Michigan; J. H. Koffolt, Ohio State University; J. J. McKetta, University of Texas; C. C. Monrad, Carnegie Institute of Technology; C. R. Wilke, University of California.

The four runners-up will be accorded honorable mention at the Award Dinner. As in years past, S. D. Kirkpatrick, retired editorial director of *Chemical Engineering*, will preside as toastmaster. The affair will be held in the Hotel Astor at New York.

ChE's to Hold Autumn Meeting in Puerto Rico

On Oct. 23-28, the Institute of Chemical Engineers of Puerto Rico is sponsoring the first Inter-American Congress of Chemical Engineering to provide a forum for an international exchange of ideas. Technical sessions will span a whole range of interests, including sugar and food technology, biochemical and sanitary engineering, petroleum technology, and chemical engineering education.

Papers are still being accepted for presentation at the meeting. For further information, write: The Secretary, Institute of Chemical Engineers of Puerto Rico, Box 47, Rio Piedras, Puerto Rico.

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UPTURN IN RAYON TIRE CORD: REVERSAL OR RIPPLE?

Rayon makers feel they are backing a winner in the new two-ply tires. They see the race with nylon shifting from price to more promising odds: quality.

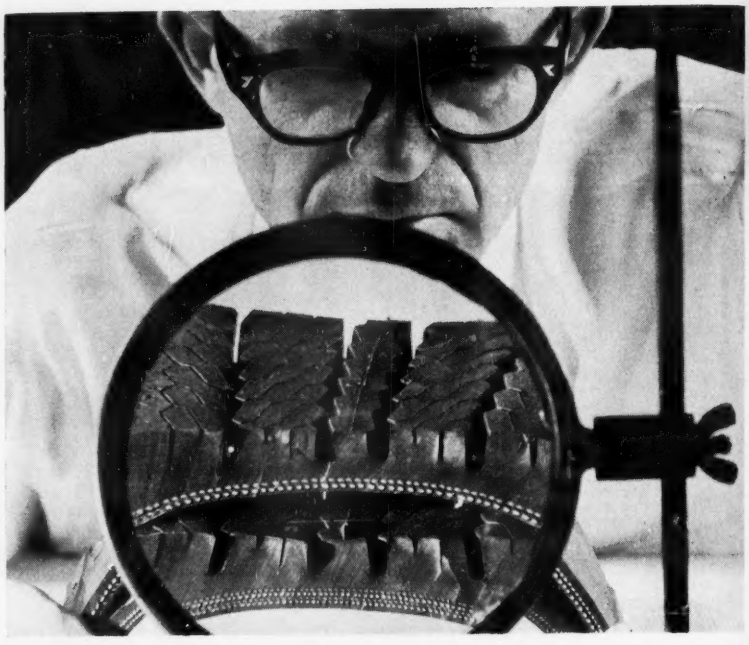
A new bounce in the rayon's industry's step is in sharp contrast to the pessimism of a year ago. After five years of steadily losing ground to nylon, rayon tire cord has succeeded in recouping a few percentage points (see right). These gains, the industry believes, are not mere zigzags in the old trend, but the beginnings of a new one. And this despite the fact that rayon dropped from 63% of the total 1959 cord production (470 million lb.) down to 57% of 418 million lb. in 1960.

Optimistically, the industry today foresees a shift in market emphasis—from price to quality; from a back-to-the-wall position to one where the older fiber has a fighting chance.

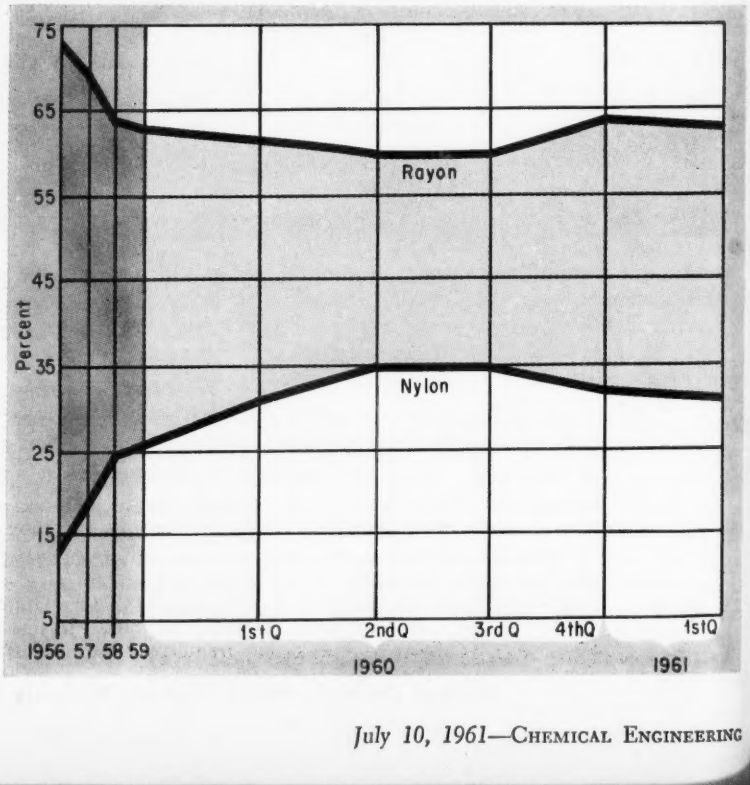
The pricing picture shows that several rounds of sparring in 1959 and 1960 brought nylon down from \$1.20/lb. to 92¢/lb., rayon from 62¢ to 54½¢. In addition, makers of cellulose for rayon tire cord cut its price 10%, early in 1960. Rayon cord prices were regarded as about as low as they could go. On the other hand, it's generally agreed that there's enough leeway in nylon's cost-profit picture to pare prices further. However, rayon managed to boost its prices back up to 57¢/lb. in the past few months.

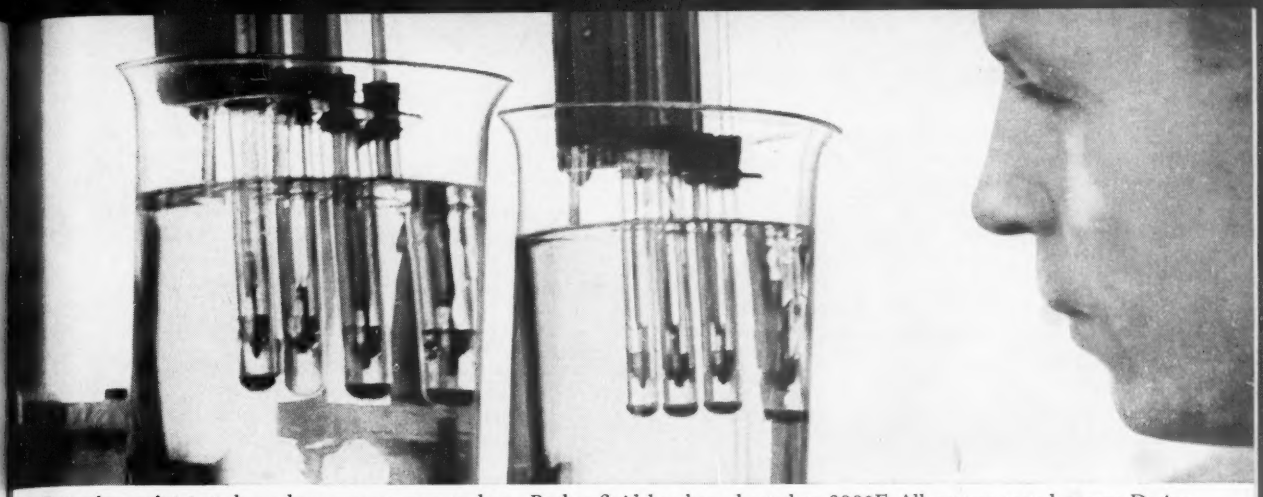
Among the factors emboldening rayon cord producers: growing acceptance of the two-ply rayon cord tire, increasing improvements in strength and other key yarn qualities, improvements in the quality of cellulose used to make cord.

▶ **Preaching Quality**—In all these factors, there's more emphasis on quality than on price. Tyrex, Inc. —the association formed three



Two-ply tires, compared (above) with conventional four plies, are among developments building new hopes for rayon makers. Halting years of steady losses to nylon, chart below shows rayon's share of total tire cord output picked up slightly in recent months as nylon's turned down.





Dropping point test shows how greases react to heat. Beaker fluid has been heated to 390°F. All greases tested except Darina (second tube from let) have passed from solid to liquid state.

BULLETIN:

Shell reveals the remarkable new component in Darina Grease that helps it save up to 35% on grease and labor costs

Darina® Grease is made with Microgel*, the new thickening agent developed by Shell Research.

Darina lubricates effectively at temperatures 100° hotter than most conventional soap base greases can withstand.

Read how this new multi-purpose industrial grease can help solve your lubricating problems and even save you up to 35% on grease and labor costs.

THERE IS no soap in Darina Grease. No soap to melt away—wash away—or dissolve away.

Instead of soap, Darina uses Microgel—a grease component developed by Shell Research.

What Microgel does

Because of Microgel, Darina has no melting point. It won't run out of gears or bearings.

Compared with most conventional soap-base greases, Darina provides significantly greater protection under adverse service conditions.

Mix water into Darina and the grease does not soften. It shrugs off water—won't emulsify.

Resists heat

Darina will withstand operating temperatures 100° hotter than most conventional multi-purpose greases. It cuts leakage and reduces the need for special high-temperature greases.

Also, Darina resists slumping, thus forming a more effective seal against foreign matter.

Saves money

Shell Darina can reduce maintenance expenses while it protects your machinery. Savings of up to 35% on grease and labor are quite possible.

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A BULLETIN FROM SHELL
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years ago to promote Tyrex, the new high-strength rayon cord produced by five major manufacturers —credits recent signs of rayon gains to the truck-tire replacement market. This is an area where nylon's bite has been particularly severe, growing from 50% in 1959 to 56% in 1960 (compared with a rise from 28% to 33% in nylon's share of total tire cord produced). But an intensive educational campaign aimed at truckers—said to demonstrate, for example, that using rayon rather than nylon cord cuts tire tread wear from 1½ mil/mi. to ¾ mil—is believed to be having its effect.

▶**Rayon for Two Plies**—Two-ply cord tires (*Chem. Eng.*, Apr. 3, p. 79) are proving a boon to rayon in its battle to retain overwhelming dominance of the market in original equipment for passenger cars. Two-ply construction, coming into increasing use for tires on compact cars, is said to offer softer ride as a major enticement to consumers. But even with the new design, the widely publicized tendency of nylon cord tires toward flat spotting remains a problem. So rayon cord—which has always laid claim to a better, softer ride than nylon cord —is benefitting from the switchover from four to two plies.

A 4% price advantage to auto makers is also helping the new design to make headway. To tire makers, two plies offer greater simplicity of handling than four.

▶**Thicker Cords**—Two-ply rayon tires are variously made with 1650-, 2200- and 3300-denier cords; they actually contain more rayon than their four-ply predecessors. For four-ply tires, a trend from conventional 1650 denier to 1100 denier started a few years ago with the introduction of new high-tenacity Tyrex yarn. Now, even in these older designs, there's a movement back to thicker cords. Rayon cord makers benefit because they can get more output of thick than thin cord from existing equipment.

▶**Stronger Cords**—Latest of a continuing series of attacks on nylon's almost mystical reputation for strength, a new and 10% stronger Tyrex rayon tire cord was introduced by Industrial Rayon in January after two years of research. The new cord is said to permit the manufacture of tires with greatly increased resistance to impact, failure and fatigue. Rayon yarns with still further improvements are forecast for the near future.

More Nylon Means More Price Cuts

	Type	Estimated Capacity (Million Pounds) Jan. 1960	Jan. 1962
Du Pont	6,6	275	335
Chemstrand	6,6	125	125
Allied Chemical	6	24	75
Dow	6	...	12
Firestone	6	...	12
American Enka	6	...	6
Beaunit Mills	6	...	2.5

▶**Better Cellulose**—Also investing in research and new facilities aimed at improved rayon tire cords are producers of cellulose raw materials. In 1959, International Paper introduced a new high-quality pulp called Tyrecell. Commercial use has since established that the new pulp affords higher yields and cord tenacities.

Considerable capital outlay was necessary to equip International's Natchez, Miss., mill to make the new product. This year, additional equipment is being installed at Natchez with, the company says, "a view to an even further step upward in the quality of tire cord afforded by Tyrecell." Also before the end of this year, Rayonier plans to start up new facilities in Jessup, Ga., to produce an improved tire cord pulp called Ultronaire.

Improved properties of the new pulps are credited to reduction of low chain-length cellulose, improving uniformity of chain-length.

▶**Price Pressure Ahead**—Actually the present 35¢/lb. price differential between rayon and nylon is not as wide as it seems, since only about one pound of nylon yarn is used in tires generally, compared with about 1.6 lb. of rayon tire yarn. And aside from nylon's desire to beat out rayon, a 50% expansion scheduled for nylon by the end of this year is building up a key ingredient of price reductions —excess capacity (see table).

Several rayon producers are playing it safe by getting into nylon themselves: American Enka and Beaunit Mills started up plants last year. However, American Viscose traded in to Monsanto its 50% ownership of Chemstrand.

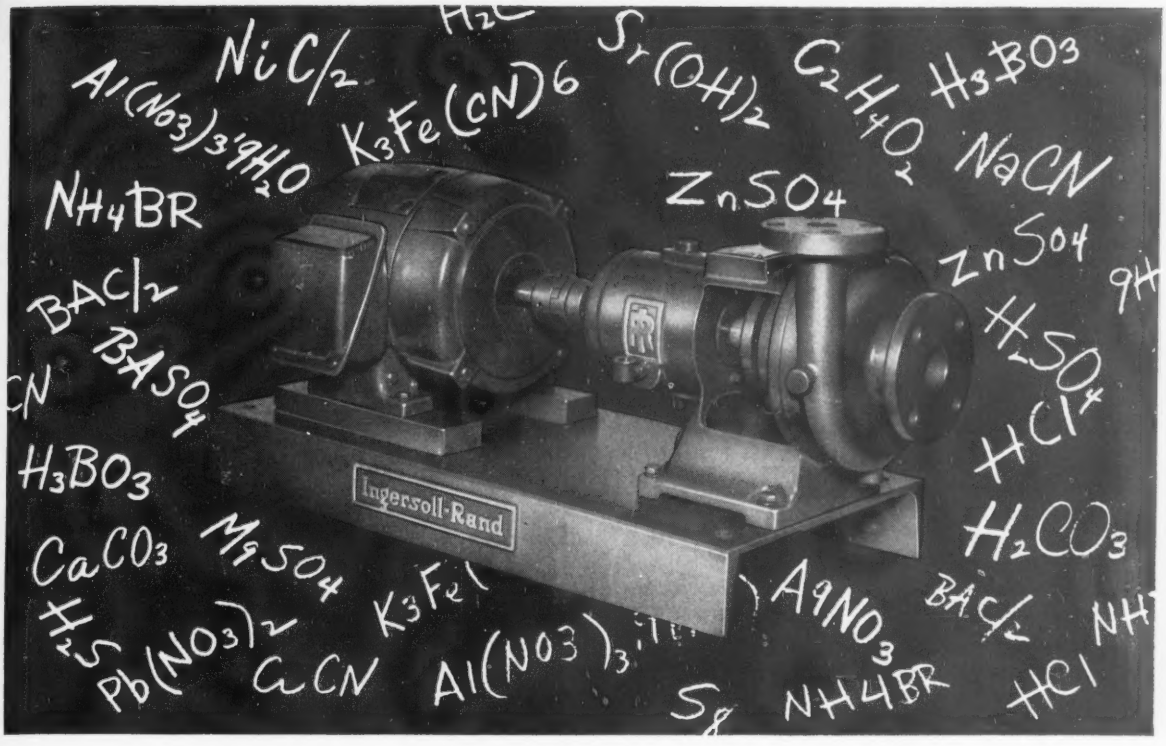
▶**Coexistence**—In February, Seiberling Rubber Co. brought up the intriguing possibility of coexistence. Company introduced the Nytex tire containing two plies of rayon under the tread—for soft riding—and two plies of nylon inside—to take advantage of that fiber's strength. Since Seiberling produces replacement tires only and most of these are nylon, the move represents something of a victory for rayon.

Combining of nylon and rayon cord in one tire is acknowledged to be a technically formidable task. Only other producer to achieve a commercial combination is Pirelli of Italy which, according to Seiberling, uses a different type of construction.

▶**New Entries**—But newer types of fibers are threatening to push into tire cord and there's no guarantee that either rayon or nylon will dominate the long range picture. Du Pont is still working on its HT-1, a polymide that melts at 600 F., compared with 482 F. for nylon. Air Reduction is planning to introduce Vinal FO, a polyvinyl alcohol fiber developed in Japan by Kurashike Rayon and said to be notable for high-temperature qualities. In Germany, Chemische Werke Huels is working on Nylon 12, a tire-cord possibility.

A number of companies have been working on polyesters which, according to a recent statement by Goodyear, may be available to the public within a year or so. The polyesters seem to have the high strength and bruise resistance of nylon without flat spotting.

Goodyear also disclosed that its research with polyolefins point to their eventual use in tire cord, though this may be a decade off. Unlike the polyesters, the polyolefin fibers are lighter than nylon but have the advantages for producing a cool-running tire. Also unlike the polyesters, molecules in polyolefins can be controlled which might allow strength to be maximized.—FA



YOU NAME THE LIQUID... WE HAVE A PUMP IN THE CORRECT MATERIALS TO HANDLE IT

Ingersoll-Rand has a new and completely integrated line of centrifugal pumps to meet the expanding needs of the chemical industry. These are cradle-mounted, single-stage, end-suction units with vertically split casing.

These new chemical pumps can be used on practically any service requiring a pump to handle corrosive or non-corrosive solutions. There is complete interchangeability of parts in units of the same size between ferrous, alloy and non-ferrous materials.

The cradle-mounted design permits driving by any dependable power source through a flexible coupling, gear or belt and sheave arrangement. Sizes range from 3/4 to 4-inch discharge, capacities range to 1000 gallons per minute, heads available to 240 feet and horsepowers from 1/4 through 50.

Our trained pump specialists are always ready to help with your problem. Call the nearest Ingersoll-Rand branch office or see our authorized pump distributor.

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Tubular car has tear-drop shape, with no internal obstructions to retain contents during unloading. Capacity exceeds that of any covered hopper car in service.

COVERED ALUMINUM HOPPER CARS WEIGH LESS, HAUL MORE

Tubular units spark added interest in aluminum as a material of construction for transportation of bulk items on land and water.

Bulk chemicals will soon be moved via rail in new, tubular hopper cars whose entire bodies are made of aluminum. Lightweight, and having a high capacity, 60 cars will carry alumina from Kaiser Aluminum & Chemical Corp.'s Baton Rouge and Gramercy, La., plants to Ravenswood, W. Va., for reduction to aluminum.

Developed, tested and produced by the American Car and Foundry division of ACF Industries, Inc., they are called "Center Flow" cars because of a channeled, gravity-unloading feature.

When the cars are placed in service late this summer, aluminum will have reaffirmed its foothold in the business of transporting chemicals by rail and water. An aluminum barge is already under construction at Todd Shipyards, Houston (*Chem. Eng.*, April 3, p. 102), for transporting perchloroethylene on the Mississippi. And Aluminum Co. of Canada is testing tubular railroad cars for shipping lime, cement, alumina, gypsum, adipic acid and polyethylene.

▶ **Why Aluminum?**—Three properties distinguish aluminum as a building material for the bulk transport of chemicals and foodstuffs:

Light Weight—With one-third the density of steel, aluminum makes lighter cars, allows an increase in payload.

Corrosion—Aluminum resists attack by many commodities that damage unlined steel.

Contamination—The metal can handle food and other products that otherwise would require special linings to protect them from reaction with the container.

Based on the construction costs reported for the Canadian firm's cars, aluminum hoppers require more investment than steel ones. Future of the lightweight carriers rests not in replacing steel units for general hauling, but in finding those specialized areas where all the above properties are valuable in handling the product.

For instance, commodities that are nationally of small importance, but whose movement is concentrated on a few railroads where they make up a substantial share of freight loadings, may best be handled in high-capacity aluminum cars.

Also, commodities previously moved in packaged form because of handling, contamination and corrosion considerations, or new items adaptable to bulk rail movement, may spark a switch in transportation habits.

▶ **Payload Advantage** — The new cars are designed to haul the maximum load with minimum loading and unloading activity. They have the highest capacity by weight of any covered hopper cars in service.

The 103-ton payload represents an increase of about 7 tons over a conventional covered aluminum hopper, and 14 tons over a steel car.

The body contains four inner compartments, each of which has two discharge gates located on the center line of the car. There are no obstructions of any kind inside that can interfere with discharge, hence unloading is easier, faster.

Capacity is utilized to the maximum because of the cross-sectional contour of the body. Its inverted tear-drop shape reduces pyramiding during loading so that only about 3% of the volume is unused, compared with about 7% air-space in a loaded conventional straight-sided hopper car.

Each unit contains 12,000 lb. of aluminum plate, from $\frac{1}{4}$ to $\frac{3}{8}$ in. in thickness. An additional 3,000 lb. of extruded shapes are used as sills. Underframe elements, truck units and brakes are steel.

▶ **Handles Many Materials**—Products that may safely be shipped in aluminum cars without fear of contamination or corrosion include agricultural products such as wheat, corn, other grains and milled flour; also, mining products such as coal, coke, ores and concentrates, particularly those that contain sulfur.

Clay, sand, gravel and phosphate rock, which tend to abrade the oxide film from steel cars, increasing the corrosion rate, are less punishing on aluminum because of its corrosion resistance. Crude petroleum and asphalt, which often contain appreciable sulfur, present no hazard to aluminum because it is not vulnerable to sulfur in either liquid, vapor or solid form.

Chemical materials that are suited for aluminum-car transport include nitrated fertilizers, fatty acids, cement, acetic acid, aqua ammonia, and formaldehyde. Nontoxic nature of aluminum also makes it suitable for shipping most foodstuffs.—FCP

STREAMLINED TANK TRUCK EASES HIGHWAY SHIPPING OF CHLORINE

For less-than-carload lots, tank trucks are becoming increasingly popular for shipment of chlorine.

Pointing the way to more economical highway transportation of chlorine, Sierra Chemical Co., Reno., Nev., recently unveiled a tank truck that had been built to its own specifications.

Tank trucking was the company's answer to a typical shipping problem. It buys chlorine from Stauffer Chemical's Henderson, Nev., plant, but there is no direct rail connection from there to Sierra's Reno facility. So, taking to the highways was a logical solution.

However, tank-truck shipping is also proving attractive to other chlorine consumers who buy less-than-carload quantities. Most small shipments are now handled in ton-multiple-units, which means that the customer has to pay for hauling one of these heavy pressure cylinders for every ton purchased.

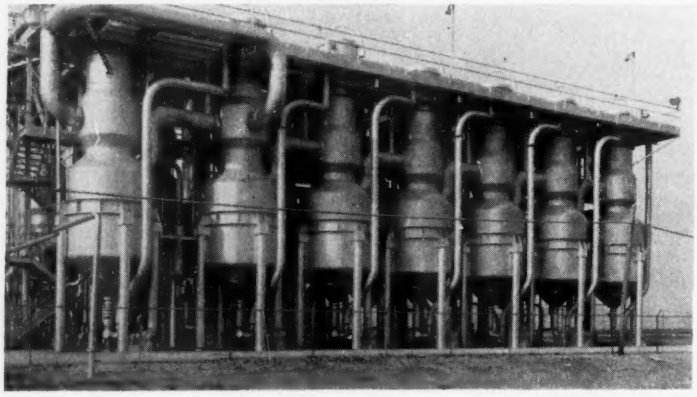
Dover Chemical Co., Dover, Ohio, pioneered the concept of chlorine truck trailers last year. And now at least two other chlorine producers besides Stauffer—FMC Corp. and Pittsburgh Plate Glass Co.—have provisions for loading customer-owned trucks.

One unique design feature of Sierra's trailer is the location of the dome. It's at the rear of the tank instead of in the middle as on a railroad tank car. This was done to avoid weakening the center of the tank, sole structural connection between rear axle and tractor.

Designed by Sierra's president, T. M. Kean, the trailer was built by Fruehauf Trailer Co. It costs $18,775, has a capacity of 3,200 gal. or 17 tons of chlorine. Fruehauf is ready to duplicate the unit.

Built according to Interstate Commerce Commission codes, the tank has a working pressure of 225 psig. Chlorine is actually held at 110 psig., the same as in railway tank cars.

Long gray line of evaporators desalts sea water



Eight million gallons of fresh water from the sea were produced in the initial eight-day test of this new Freeport, Tex., water desalination plant built by Chicago Bridge & Iron Co. for the U. S. Office of Saline Water. The 12-evaporator plant (seven are shown above) uses long-tube vertical evaporation with multiple effects, to turn out 1 million gal./day at a cost claimed to be less than $1/1,000 gal. Design of this experimental system allows for extensive materials testing, which is the key to cost reduction in the evaporation process.

Tax Credit: Is It a Boost For Capital Investment?

The question of whether the government's proposed tax credit on extra spending for new plant and equipment actually offers a significant investment incentive is drawing mixed reactions from industry.

Robert C. Tyson, chairman of U. S. Steel's finance committee, recently described the government's proposal as "seeking to counterbalance while deferring correction of the depreciation situation . . . I have fears that disagreement on how to do what all agree should be done may result in nothing being done."

And Armco Steel Corp.'s president, Logan T. Johnson, says that "the President's proposal is hardly a step toward improving foreign relations or helping American business overcome the government-created deficit in international payments."

On the other hand, textile industry spokesman James Barringer, vice president of Crompton & Knowles, expresses surprise at these adverse reactions. "Whether complicated or not, any proposal that results in lower tax costs is worth looking at twice, since increasing earnings is an important reason for being in business," he declares.

The government's proposal would allow a company to subtract from its final tax bill an amount equal to a percentage of its new investment in plant and equipment. A company could claim a credit of 15% of all new plant and equipment expenditures in excess of current depreciation allowances. It could also claim a 6% credit on the portion of new investment between 50 and 100% of its yearly write-off for depreciation on existing installations.

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That's because her lovely new cotton dress is bleached in Becco Hydrogen Peroxide. With this bleach, finishers produce dress goods with a good clear white and no reversion. What's more, dyed shades are brighter and they stay that way. And, converters and retailers find their customers are happier, since their garments stay brighter longer.

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Plants

Wyandotte Chemicals Corp.'s Michigan Alkali Div. will build a $3.5-million propylene oxide plant on a 23-acre waterfront site at Wyandotte, Mich. President R. B. Semple announced the move "to meet the growing demands of detergent and urethane markets." Construction begins in a few months.

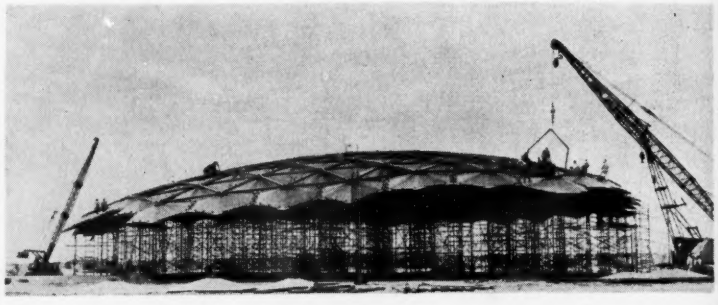
Shell Oil Co., heading up a seven-firm venture, plans to build and operate for the consortium a gas-processing plant near Yscloskey, La., southeast of New Orleans in St. Bernard Parish. Unit is designed to extract 10,000 bbl./day of hydrocarbon liquids from 650 million cu. ft./day of natural gas in the rich Mississippi Delta fields. Approximately 90% of the propane, and all of the isobutane, butane and natural gasoline, will be recovered from the gas stream and sold to Tennessee Gas Transmission Co. (after further processing by Union Texas Natural Gas Corp. in nearby Toca, La.). The other firms in the group are The California Co., Cities Service Products Co., Humble Oil and Refining Co., Continental Oil Co., Atlantic Refining Co. and Tidewater Oil Co.

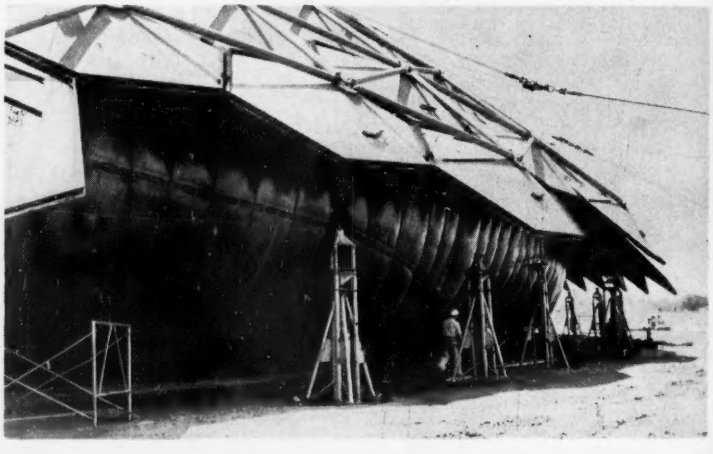
Sinclair Refining Co. announced at its stockholders' meeting on May 17 that the company's ortho-xylene unit at Houston went quietly on stream in March. Houston complex is the company's largest petrochemical installation, with capacity for 125 million lb./yr. of para- and ortho-xylene, 2,800 bbl./day of aromatic solvents, and 800 bbl./day of ethyl benzene. Adjacent refinery can charge 159,000 bbl. of crude oil daily.

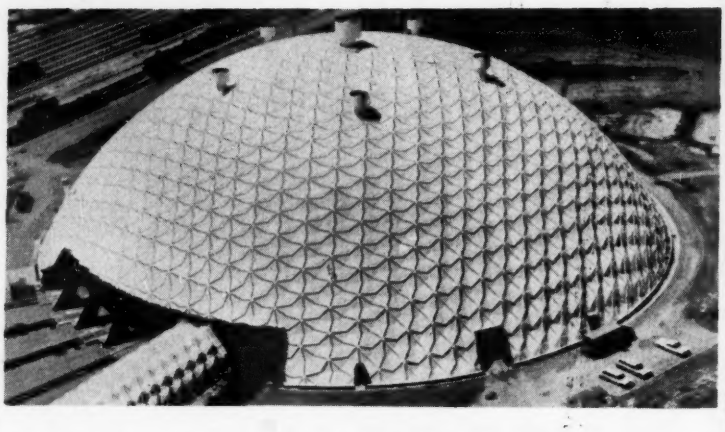
Columbian Carbon Co. plans a $2-million expansion of its carbon-black plant at North Bend, La. New facilities will boost capacity, provide greater scheduling flexibility.

Turn to p. 174 for more CPI News Briefs

Ten-story "turtle" covers 2½ acres







Union Tank Car Co.'s *repair plant in Wood River, Ill., is probably the world's largest structure to be built from the top down: (1) topmost steel plates for the geodesic dome are attached to one another on 2½ acres of scaffolding* **(top photo)***; (2) nylon balloon is inflated* **(middle)** *beneath the partially built structure, scaffolding is removed, lower plates are added from the ground while nylon bag is gradually puffed from two up to ten stories high; (3) finished shell* **(bottom)** *covers an area the size of a baseball park—without inside support.*

MONOMOLECULAR FILMS PROVE EFFECTIVE DUST KILLERS

Sprayed onto powdery process materials, cationic flotation agent is on-the-job success as anticaker, antiduster.

Chalk up another success story for serendipity. An observation first made more than 15 years ago at Carlsbad, N. M., is the basis for recent commercialization of Armour Industrial Chemical Co.'s Armoflo anticaking and dust-control agents.

Certain potash producers at Carlsbad observed that potassium chloride (sylvite), processed by flotation, didn't cake in storage. This property was traced to the presence of minute residual concentrations of cationic flotation reagents adhering to the sylvite particles. For years, this observation was held a trade secret—even now, Armour has not disclosed specific compositions of its Armoflos, pending action on patent applications.

Now, just two years after their introduction, these cationic agents are being widely used for anticaking and dust control of such materials as sulfur, diammonium phosphate, ammonium chloride, granular mixed fertilizers, caustic soda, thermosetting plastics, insecticides, sodium nitrate, urea, powdered glue and pentachlorophenol. In the development stage is treatment of phenolic molding powders, prilled ammonium nitrate, detergents, metallic soaps and dextrine-urea blends.

▶**Trace Quantities**—There's nothing new about anticaking agents: clays and diatomaceous earths, for example, have been conditioning hygroscopic materials for many years.

But the Armoflo formulations do the job on an entirely different basis. Where it normally takes 30-50 lb. of clay to treat a ton of hygroscopic solids, only 0.5-1 lb. of liquid cationic agent is now needed. When sprayed, this is enough to coat each solid particle with a monomolecular film. Therein lies the clue as to how these materials function; this layer prevents adsorption of atmospheric moisture onto the coated particle.

▶**Warmly Applied**—For good dispersion, original Armoflo formulations had to be applied at about 200 F. Now, however, formulation improvements permit application at about 150 F. (These temperatures refer to the materials; for best results, the reagent should also be warm.)

Application is straightforward: Armoflo products disperse within five to ten minutes when mixed in a rotary drum, blender, screw conveyor or other suitable device. In fertilizer plants, the rotary cooler provides an ideal spot for adding the agent. It is dispensed from a heated drum by a gear pump through a simple atomizing nozzle; metering is not critical for the agent's success.

▶**Serendipity Squared**—While developing pour-point depressants for lower-temperature application of the cationic anticakers, Armour came up with formulations yielding an unlooked-for but highly desirable byproduct feature—dust control. Considering today's emphasis on air-pollution control, this last accidental discovery opened up even wider markets for the agents.

However, the company faces two deterrents to the growth of the Armoflos: soluble salts treated with these products are more difficult to put into solution, and Food & Drug Administration approval must be obtained for some potential applications. But the firm is highly optimistic about the future of these new products.—**Armour Industrial Chemical Co., Chicago.** 80A

Diphenyl mercury

Commercial for the first time, powder leads to cheaper polymers.

Till now an expensive laboratory chemical, diphenyl mercury has been synthesized in Britain by a "simple, direct" process (no details are yet available). The white microcrystalline powder contains about 56.5% Hg, is potent as an arylating agent, polymerization catalyst, biocide and fungicide.

Though its more obvious applications are in timber and textile treatments (for built-in resistance to fungi), the newly available, cheap diphenyl mercury is of particular interest for its ability to introduce mercury into polymer systems.

Recent patents indicate the chemical's profitable catalysis of polypropylene. Also, it is known to accelerate vinyl polmerizations (styrene and vinyl acetate in particular), and is believed to effect the arylation of organic compounds of such metals as Cd, Sn, B and As more easily than the Grignard reaction.—**F. W. Berk & Co. Ltd., London.** 80B

Acrylic coating

Nonflammable liquid makes coating that can be soldered.

Said to be the first solvent-type acrylic coating that's nonflammable in liquid form, HumiSeal 1B20 is air-drying, single-component, able to be soldered. Manufacturer expects it to obviate "red-label" storage and production areas; heavy users of solvent-type coatings (e.g., the electronics industry) will certainly find it a boon to safety.

The acrylic-base coating has a solids content by weight of 20%; density, 11.4 lb./gal. Color is clear. It touch-dries in 15 min., finish-

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dries in 2 hr. (though stable optimum properties aren't reached until a full day after application). While the coating does weather well, abrasion resistance is claimed to be only "fair."—**Columbia Technical Corp., Woodside, N. Y.** 80C

Epoxy pellets

Melted in place, pellets eliminate need for messy liquid adhesives.

The proverbial light bulb must have flashed when someone thought up this one: epoxy pellets that bond by melting. The idea is simple, yet with a stroke wipes out the four most serious drawbacks of epoxy resins as adhesives: difficulty in mixing, metering, applying; and skin irritation.

The tiny pellets come in a host of sizes (0.085-0.5 in.), shapes (hollow, solid, cylindrical, oblong, holed) and prices ($2.50-$12/thousand). Much of the new idea's appeal lies in the well-known ability of epoxies to bond practically anything to practically anything else (its steel-to-steel shear strength, for instance, is 4,700 psi. —softer materials tear before the bond fails).

Here's how: pellets are placed between the materials to be bonded. Heat is applied (as low as 85 C. if materials are heat-sensitive, as high as 250 C. for a fast-cure bond). Pellets melt; materials are bonded. That's all there is to it.

Minuscule size of the pellets makes them ideal for bonding delicate precision parts; absence of runover, mixing, cleaning and the like suit them for production lines. —**Epoxy Products, Inc., Irvington, N. J.** 82A

Air filter

Glass fibers filter out 0.3-micron radioactive or bacterial particles.

Rated for continuous operation at 500 F. (most others work only up to 200 F.), and guaranteed to stop 99.7% of all air-borne particles sized 0.3 microns or more, this glass-fiber filter pad is specifically designed for aerosol-type applications.

Key to the filter's high-temperature operation is the adhesive that bonds the mat of 1-micron-dia. glass fibers to a paperboard frame. The rubber-base adhesive, called Pliobond, was developed by Goodyear Tire and Rubber Co.; the glass-fiber mat is a joint development of Mine Safety Appliance Co. and Hurlbut Paper Co.; while the fabrication of matting into filter media is a sole Mine Safety technique (based on the firm's Manhattan Project work on radiation during World War II).

The filter medium is folded into an accordion or honeycomb pattern, effectively eliminating separators and reducing the filter's weight (comparable filters in the 1,000-cu. ft./min. size would weigh 40 lb.; this one weighs 9 lb.). Filter area through which the air must pass is increased by the pattern, while side-wall friction is reduced.

Largest existing markets for this type of filter are probably in atomic energy, where all air passed through "hot" areas must be cleaned; in pharmaceuticals, where colonies of bacteria waft about production areas; and in photography, where radioactive particles splotch unexposed film. —**Mine Safety Appliance Co., Pittsburgh.** 82B

Carbon-8 chemicals

Two more cyclic C-8 hydrocarbons are synthesized from butadiene.

Cities Service has brought to six the number of C-8 compounds in its family of butadiene-derived petrochemicals (*Chem. Eng.*, Feb. 6, p. 33). The newcomers, available in research quantities: 1,3-cyclo-octadiene and 1,5,9-cyclo-dodecatriene.

Company admits it doesn't yet know what the new cyclic petrochemicals can do best. As a starter, the 1,3-cyclo-octadiene could prepare new Diels-Alder adducts with reactive dienophiles; while 1,5,9-cyclo-dodecatriene—predominately the all-*trans* isomer—is expected to lead to a variety of di- and trifunctional twelve-carbon chemicals. Currently, the best known of these C-12 compounds is 12-amino-dodecanoic acid lactam, a monomer easily converted into a polyamide resin.

The 1,3-cyclo-octadiene is obtained by catalytically rearranging the double bonds of 1,5-cyclo-octadiene, a butadiene dimer. The 1,5,9-cyclo-dodecatriene is a cyclic trimer of butadiene, also converted by the company's closely guarded new catalyst.

Cities Service's other C-8 chemicals, 1,5-cyclo-octadiene, cyclo-octene, cyclo-octane and 4-vinyl-cyclohexene, have been available in development lots from a 50,000-lb./yr. Lake Charles, La., plant

Newsworthy Chemicals

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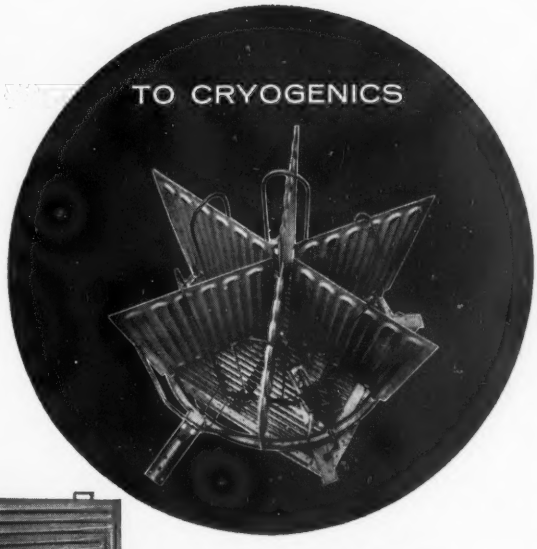

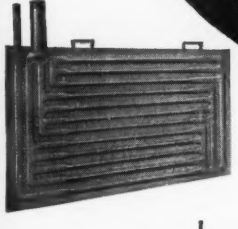

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since January. Projected applications: nylon, adhesives and coatings, synthetic lubricants.—**Cities Service Research and Development Co., New York.** 82C

Vinylidene copolymer

Emulsion of polyvinylidene chloride copolymer makes a coating latex.

Described only as a "copolymer of polyvinylidene chloride and other things," Daran latex is now commercially available for the first time (at 45¢/lb. for 60% solids).

Paper and board coated with the new latex are said to have higher moisture resistance per unit weight than those protected with other coatings. Daran is virtually impermeable to grease, gas and a selected list of chemicals.

J. L. Ohlson, who headed the research team that developed the coating, notes that patents are pending; hence, little of Daran's chemistry can be released. Product is a "synthetic latex"—though how it is formed remains a secret.

Daran contains a "higher proportion" of vinylidene chloride than does its well-established sister, Saran; though how much higher—and higher than what other monomer—Ohlson refuses to say.—**W. R. Grace & Co., Dewey and Almy Chemical Div., Cambridge, Mass.** 84A

Filament-winding epoxy

Resin has low viscosity, built-in catalyst to solve handling woes.

Dubbed Bakelite ERL-0500, this trifunctional epoxy resin was developed specifically for filament winding. Long pot life, low viscosity (2,000-4,000 cps. at room temperature) and built-in tertiary amine catalyst combine to ease the woes of handling filament-winding resins.

High-temperature curing has no detrimental effect on ERL-0500's structural properties, though it does increase the resin's heat-distortion point considerably. Girth stresses up to 120,000 psi. and interlaminate shear values of 4,000 psi. have been developed with a joint ERL-0500 and methyl-nadic-anhydride system.

Such an anhydride-epoxy system has an initial viscosity of 550 cps. at room temperature, shows no appreciable increase up to 72 hours. Typical of ERL-0500 joint systems, long pot life permits the winding of complicated glass patterns with no limit on winding time or pattern complexity.—**Union Carbide Plastics Co., New York.** 84B

Briefs

Vinyl/acrylic copolymer dispersion, X-Link 2833, is capable of crosslinking without the addition of thermosetting resins (in contrast to conventional thermoplastics), forming strong yet flexible films that resist water, other solvents and creep. The "X" in X-Link 2833's name is appropriate; manufacturer holds the product's makeup a secret.—**National Starch and Chemical Corp., New York.** 84C

Fluorocarbon dispersion Dri-Lube is a dry film lubricant that promises to end sticking, freezing, galling and abrasion that occur during fabrication of metals, plastics and paper. It is inert to nearly all acids, alkalis and solvents. The slick surface provided by Dri-Lube remains unaffected from −120 F. to 500 F. — **Fluoro-Plastics Inc., Philadelphia.** 84D

Aclar fluorohalocarbon film and **Capran polyamide film** both have high volume and surface resistivities, good power factors at low frequency, low dielectric constants. Promising applications are seen in printed circuits, electroluminescent panels and capacitor insulations. Other properties: Aclar is transparent, has virtually zero moisture absorption, resists most organics and all inorganic acids and alkalis; Capran is clear-to-hazy, has low gas permeability and excellent oil and grease resistance.—**Allied Chemical Corp., New York.** 84E

Thiodipropionic acid, an antioxidant and stabilizer for foods, fats, oils and pharmaceuticals, is now available in commercial quantities. Acid has been approved by the Food and Drug Administration for use as a food additive and in food packaging.—**Evans Chemetics Inc., New York.** 84F

Di-tridecyl phthalate, a primary vinyl plasticizer inhibited with 0.25% bisphenol A, offers low fogging characteristics and good soapy-water resistance for vinyl upholstery and gasketing. Properties also suggest use in high-temperature wire insulation and jacketing compounds requiring oil and water resistance.—**Union Carbide Chemicals Co., New York.** 84G

Modified styrene-butadiene latex, Pliolite Resin Latex 481-X, when coated on metals, will dry to a strong, nontacky film that protects surfaces from corrosion and rust. Specifically designed as a metal primer, this latex does not contain flammable solvents and can be pigmented without danger of deterioration during shelf life. Its adhesion to steel is reported as excellent. —**Goodyear Chemical Division, Akron, Ohio.** 84H

Butyl synthetic rubber claims unusual molecular structure, ozone resistance higher than any other commercial general-purpose rubber, longer life because of less embrittlement. Manufacturer predicts widespread use of the new rubber as a construction material, i.e., curtain walls, sealing for window and panel edges, extruded and molded goods.—**Esso Research and Engineering Co., New York.** 84I

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 201)

INLINE DESIGN CUTS CONTROL VALVE'S PRESSURE DROP

Streamlined internals reduce turbulence, promote smooth flow despite throttling. Compact unit operates with hydraulic, pneumatic or electronic automatic controllers.

A control valve that appears to be just a bulge in the line can in reality exert fast on-off and throttling control of oil, gas, water and chemicals.

Called the Fluidal valve, the device incorporates a cylindrical piston and a streamlined seat mounting that provide tight shut-off, and minimum pressure drop when open.

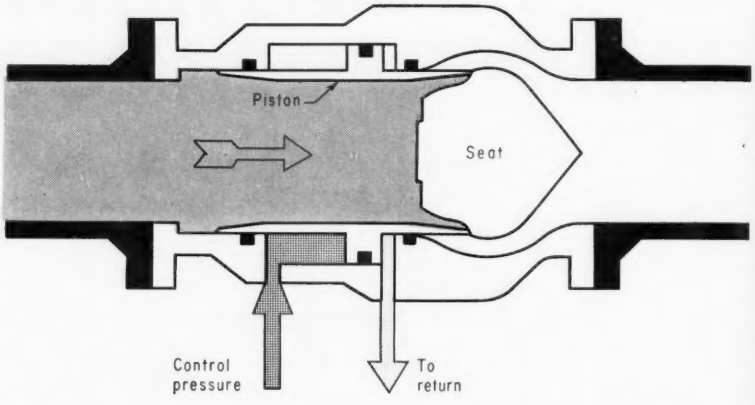
Operated directly or remotely by hydraulic, pneumatic or electronic automatic controllers, the valve is said to have an extremely fast response. It has reacted to imposed frequencies as high as 120 cycles/sec. in electro-hydraulic systems.

▶ **Simplicity**—The Fluidal valve contains only one moving part—the piston. This is held in the closed position with a spring, is sealed around its periphery on a nonmetallic gasket. Supported by webs, the seat that holds the gasket is centered in the housing. When the valve is open, flow is directed smoothly past the gasket and piston tip, to minimize erosion of internals.

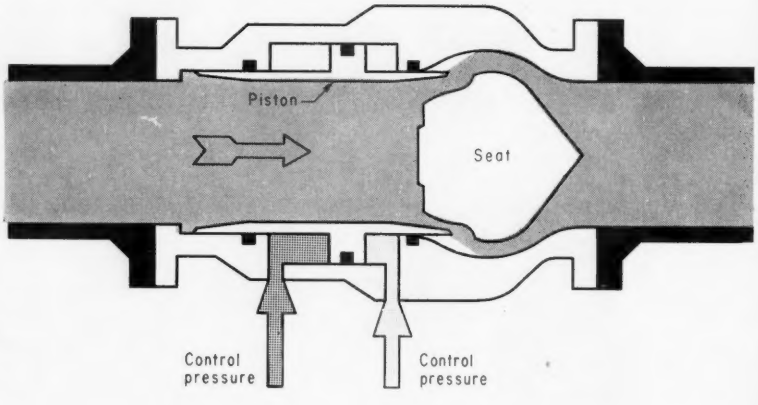
From its normally closed position, the valve is driven open by hydraulic pressure until the desired flow is obtained. Pressure on both sides of the piston annulus is then balanced to hold the piston stationary. Main-line pressure may be used to actuate the valve, making it unnecessary to rely on an auxiliary power source.

The valve is also equipped with a visual position indicator, which contains mounting lugs for attaching an electric or pneumatic valve positioner, or a transmitter for remote indication and control.

Hydraulic pressure closes valve tight, or . . .



. . . controls opening to give desired flow rate.



▶ **Throttling Patterns**—Throttling characteristics of the valve may be varied according to the application. The standard valve develops a linear pattern, with per cent flow equal to per cent of valve opening. Special throttling curves are also available to increase throttling accuracy in either the low or high portion of the flow capacity.

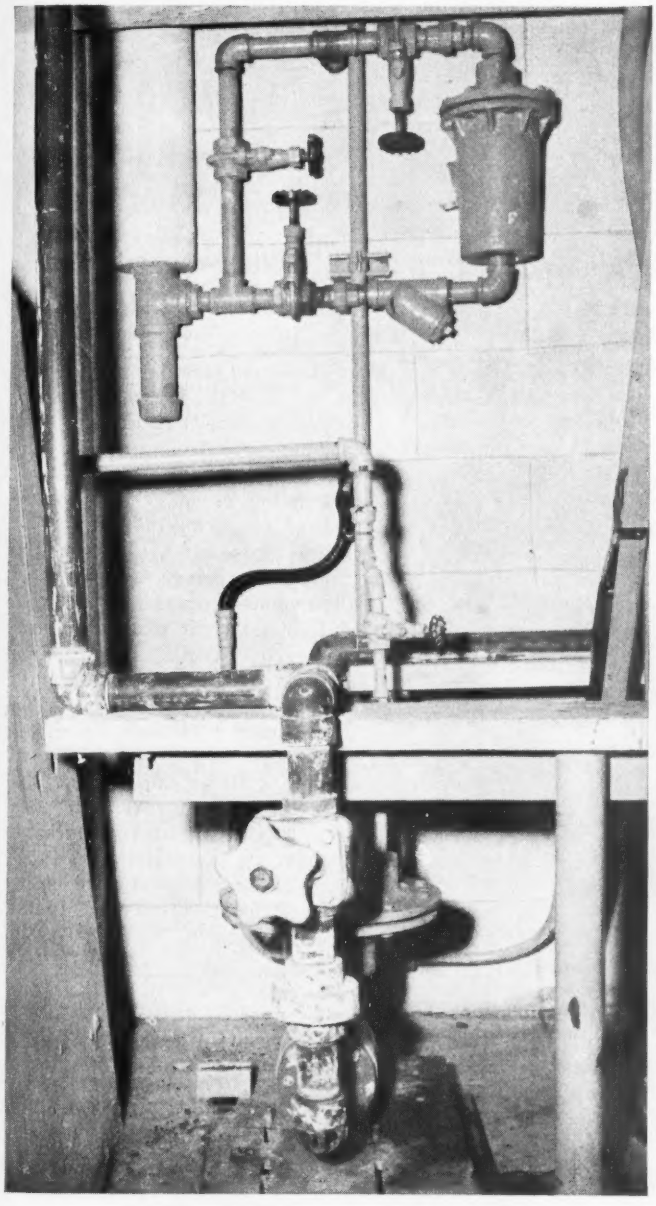
Standard unit withstands −65 to +400 F., 25 to 12,000 psi. Valves beyond these ranges are available on request.

Fluidal valve may be adapted to an existing 3-15 psi. pneumatic control system by the addition of an independent pressure-source relay. Operating pressure for normal response is 10-50 psi.; faster response requires higher pressures.

▶ **Low Pressure Drop**—In comparison with normal gate, angle,

METAL REFINING: New Role For Penton*

Solid Penton pipe and fittings prove easy to install and maintain, and low in cost



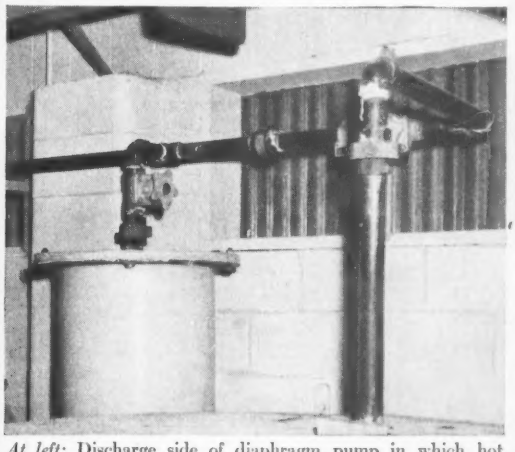
The Wah Chang Corporation has found an important new use for Penton at its Albany, Oregon, plant where columbite and tantalite ores are refined to obtain columbium and tantalum.

More than 100 feet of 1½ inch Schedule 80 pipe, threaded tees, 90° elbows, unions, and nipples—all made of solid Penton—are serving in transfer lines in the Wah Chang process, where columbium and tantalum are separated by liquid-liquid extraction and the oxide products are reduced to metal by carbon reduction.

In selecting the process equipment, Kenneth W. Bird, Process Engineer, says: "The extreme ease of installation and comparative cost of Penton pipe and fittings versus other materials which could handle this rough piping job, make Penton by far the most advantageous material we could employ. Our product must be of the highest purity, and Penton exhibits the greatest degree of inertness to the materials being handled of any competitive product on the market."

Write for complete facts about Penton and a list of fabricators and suppliers of Penton processing equipment.

Pipe and fittings used at Wah Chang were supplied by Tube Turns Plastics, Inc., Louisville, Ky., through its West Coast distributors, Esco Corporation.



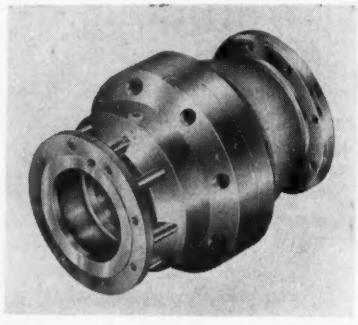
At left: Discharge side of diaphragm pump in which hot (210°F.) 15% HF solution and K_2TaF_7 (Potassium fluo tantalate) is transferred to crystallization tanks through Penton system of 1½" Schedule 80 pipe and threaded fittings. *Above:* Transfer line into crystallization tanks is solid Penton pipe.

*Penton is the Hercules Powder Company registered trademark for chlorinated polyether.

HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower, 910 Market Street, Wilmington 99, Delaware

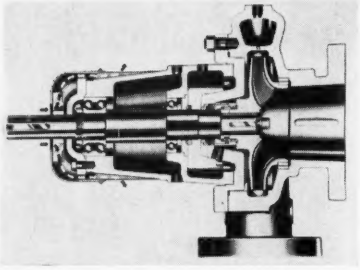
CPG1-8

globe and other types of control valves, the Fluidal is compact and has extremely good pressure-drop characteristics. Head loss through the valve for equivalent flows is about the same as for a gate valve, and up to ten times less than for globe and other types of control units.



Hardly larger than the line itself, the Fluidal valve takes a minimum of space for control purposes.

Standard valves are available from ½ to 24 in. Special designs as large as 72 in. can be furnished. Valve can be made of wrought iron, carbon, high alloy and stainless steel, manganese bronze, Monel, and aluminum alloys. Ends may be flanged, screwed, tubing and quick-connect, or weld ends. **—Bendix-Pacific Div., No. Hollywood, Calif.** **86A**



Centrifugal pump

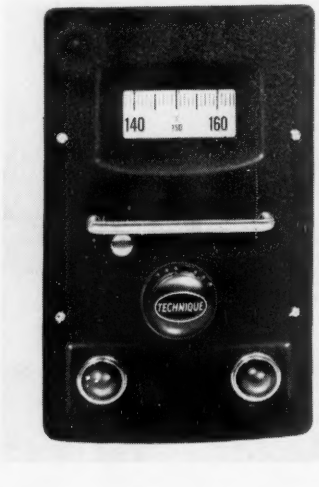
Two basic units can meet most process pumping requirements.

By interchanging impellers, covers, nozzle arrangements, bearing construction, cooling methods and other components, users of two basic new pump units can meet requirements for most pumping service.

Model SMJ is designed for high temperature service with either top or end suction. Vertically split with centerline-support mounting, it has a water-jacketed stuffing box for either packing or mechanical seal. Sizes are available with capacities to 1,200 gpm., for differential heads to 1,600 ft., pressures to 1,000 psi., and temperatures to 850 F.

The SMJI is an internally sealed version of the SMJ using a mechanical seal as standard construction. It is good to only 400 F.

All pumps in the line feature an air-cooled bearing housing. A special built-in fan cooling system eliminates the need for a cooling water supply to the bearings in certain uses. **— Byron Jackson Pumps, Inc., Los Angeles.** **88A**

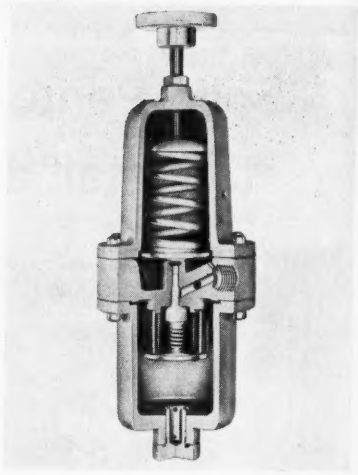


Temperature controller

Small unit handles range from —150 F. to +1,050 F.

A resistance-bulb signaling device, this controller offers a choice of on-off or proportioning control over its entire range. The unit uses only one probe and indicates the temperature on scales in 1-deg. gradations and 300-deg. spans for both Fahrenheit and Centigrade.

Each unit requires about 5 × 8-in. panel space.**—Technique Associates, Indianapolis.** **88B**



Filter-regulator

High-capacity unit with one-piece inner valve gives tight shutoff.

Filter and regulator are combined in this pressure-reducing and relief valve that provides tight dead-end shutoff. It can be used at inlet pressures to 150 psi., is available in four controlled pressure ranges from 0 to 125 psi.

The regulator has a sensitive diaphragm-spring combination. The one-piece inner valve is made of Delrin 500, a plastic material with good tensile strength and abrasion resistance but sufficiently resilient and elastic to provide a tight-sealing soft seat.

Filtration is provided with a 40-micron cylinder filter made of phenolic-resin-impregnated cellulose. Unaffected by contaminants common to pneumatic systems, filter is accessible by removing dripwell bowl.**—Kieley & Mueler, Inc., Middletown, N. Y.** **88C**

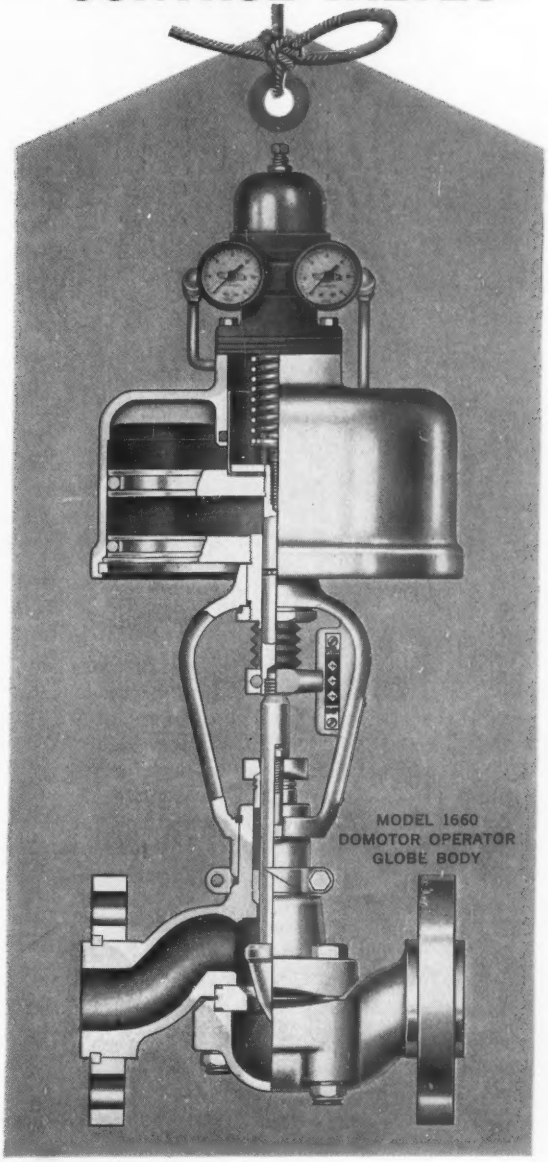
Proportional controller

Instrument reduces cycling, prevents overshooting of preset limits.

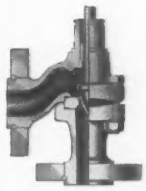
This proportional controller receives process information from primary instruments such as indicators or indicating controllers, evaluates it, and converts it to an operating signal.

Accurate to 0.25% of its span, this unit superimposes preselected

WHY ANNIN IS THE CHEMICAL INDUSTRY'S LEADING SUPPLIER OF CONTROL VALVES

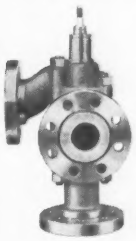


Annin control valves have been designed with the needs of the process industries in mind. The split body, single seat construction reduces body turbulence and erosion, gives longer life. The interchangeability of Annin valve components, the easily replaceable trim, the option of angle or 3-way bodies carried in stock for immediate shipment, simplifies your installation and maintenance problems. The flexibility in basic design cuts down on the valve parts inventory ordinarily required for a variety of plant applications. Another factor is the $1½ million in alloy body parts regularly carried in Annin stock, including a wide range of 300 series stainless steels, Hastelloys, Monel, Inconel, Durimet-20, and a variety of bronzes. If reduced valve inventory, design flexibility, and economical maintenance are factors in your operation, we suggest you investigate the advantages inherent in Annin process control valves.



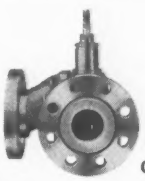
ANGLE BODY

For fluid problems involving solids in suspension, high viscosity fluids, and applications requiring special nozzle materials or design.



3-WAY BODY

Provides two horizontal line connections and an individual bottom vertical line connection. Sections may be rotated for convenience.



CORNER BODY

Standard for body sizes ½"–2". Often used to replace expensive alloy ells, this body simplifies installation and conversion on the job.

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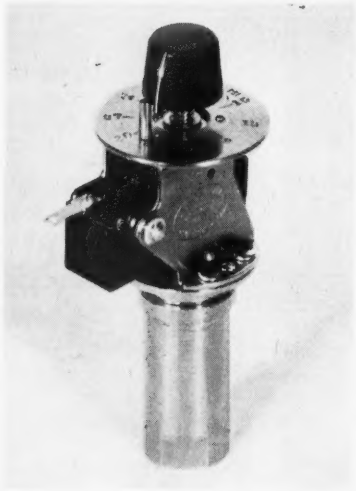
time and rate functions and amplifies the modulated signal electronically.

Control adjustments are located on the front panel for set-point, load range and proportional band control. Device incorporates a fail-safe circuit. If inadvertently mis-set, oscillation of process conditions will not occur, according to the maker.—**Thermo Electric Co., Inc., Saddle Brook, N. J. 88D**



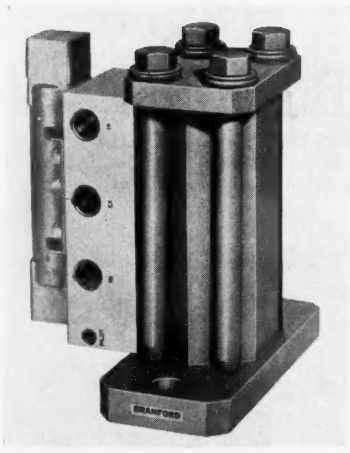
Pressure-vacuum control

Calibrated dial provides adjustment over wide pressure range.

Designed without an enclosure, for direct incorporation into equipment, a pressure-vacuum control has several adjustable ranges within the limits of 30-in. Hg vacuum and 500 psi. On-off differentials are 6 ± 1 in. H_2O and up.

Switch action includes normally open and closed, and double throw. Unit is suitable for temperatures from ambient to 180 F. Mounting bracket and bellows housing are brass. — **United Electric Controls Co., Watertown, Mass. 90A**

For more information about any item in this department, circle its code number on the Reader Service Postcard (Page 201)



Pneumatic hammer

Blows can be directed toward or away from the base mount.

Called Vibrajust, a pneumatic sledge hammer features manual control of impact frequency. Blows can be directed either toward or away from the base mount—or in both directions—with uniform or varying impact.

Either manual pushbutton control, or solenoid valve for remote control, can be used. Unit requires less than 20 cu. in. of air per blow, serves well in applications where available air supply is limited.

The hammer is available in a dustproof model, is suitable for use in industries such as food processing because it is nonlubricated. Of steel construction, it may be mounted in any plane, requires 3-80 psi. line pressure for operation. — **The Branford Co., New Britain, Conn. 90B**

Alternator control

Automatic unit actuates duplex pumps, meets varying needs.

Called the Protectal Alternator, a controller for actuation of duplex equipment has a minimum of moving parts, requires no lubrication or adjustments. Entire assembly is mounted on a single panel.

The unit is controlled by conventional pilot devices, such as float controls, pressure switches, thermostats, probes, etc. Two heavy-duty solenoids (one for emergency use) operate separate pump switches at predetermined time intervals or when specific fluid levels are reached.

The controller handles the following sequences automatically:

Normal Condition—For continuous or on-off pumping, it insures that both pumps work at alternate intervals for equal distribution of pump wear.

Emergency Condition—If pump failure occurs, unit automatically actuates second pump, operates it until defective pump can be replaced.

Increased-Volume Condition—If, during normal cycle, fluid handling volume is increased beyond the capacity of one pump, controller turns on second pump until load peak is passed. A signal alarm can also be operated. — **Protection Controls, Inc., Skokie, Ill. 90C**

Centrifugal fan

Unit operates efficiently at direct-connected motor speeds.

With airfoil blading and direct a.c. drive, this series of heavy-duty industrial fans is suited for applications such as: combustion air for steel mill and industrial furnaces; packaged steam boilers; and for industrial processes such as glass cooling, vacuum drying, and exhaust from aluminum-pot lines.

The Series 8500 fans feature heavy steel construction and bearings that are integral with the fan unit, as well as an operating temperature range from −20 to 800 F.

An adjustable vane control is an optional accessory. It causes the entering air to spin in the direction of wheel rotation, changing fan performance so that fan output can be regulated to any desired volume at the exact pressure needed.

With capacities from 15,000 to 450,000 cfm., the units run at

New Equipment continues on page 186

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½' x 11' x 8' PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

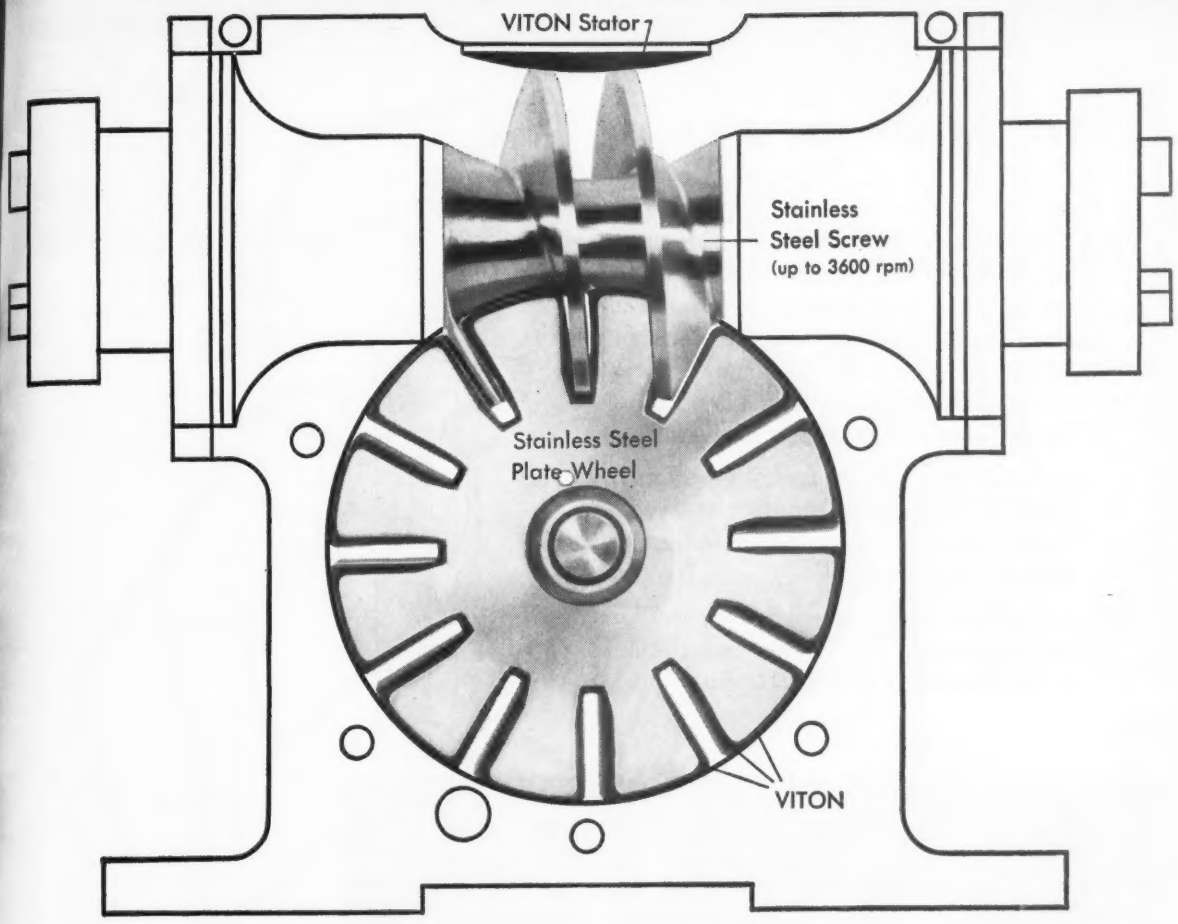
Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.



Durable VITON® helps solve corrosion, heat problems in design of new pulseless pump

A new twist on the 2000-year-old Archimedean screw principle has resulted in this unique positive-displacement pump, designed to handle highly viscous liquids and slurries containing abrasive and crystalline particles, without damage to crystals.

The key to the efficiency of this Goodyear* pump is the VITON-bonded plate wheel (see diagram). The slots are edged with durable VITON, which not only prevents galling, but exerts a squeegee wiping action that keeps "problem" liquids moving at full flow, without foaming or agitation.

Du Pont VITON was chosen for this application because of its exceptional resistance to corrosive chemicals and oil at high temperatures. No ordinary elastomer—natural or synthetic—could stand up to the corrosive attack while maintaining a positive seal at rotor speeds up to 3600 rpm.

This is just one of the many applications where only VITON solves the problem. For more examples, and detailed performance data, just mail the coupon below.

**A product of Goodyear Pumps, Inc., New York, N. Y.*

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Please send me your FREE booklet that contains technical data about VITON synthetic rubber.

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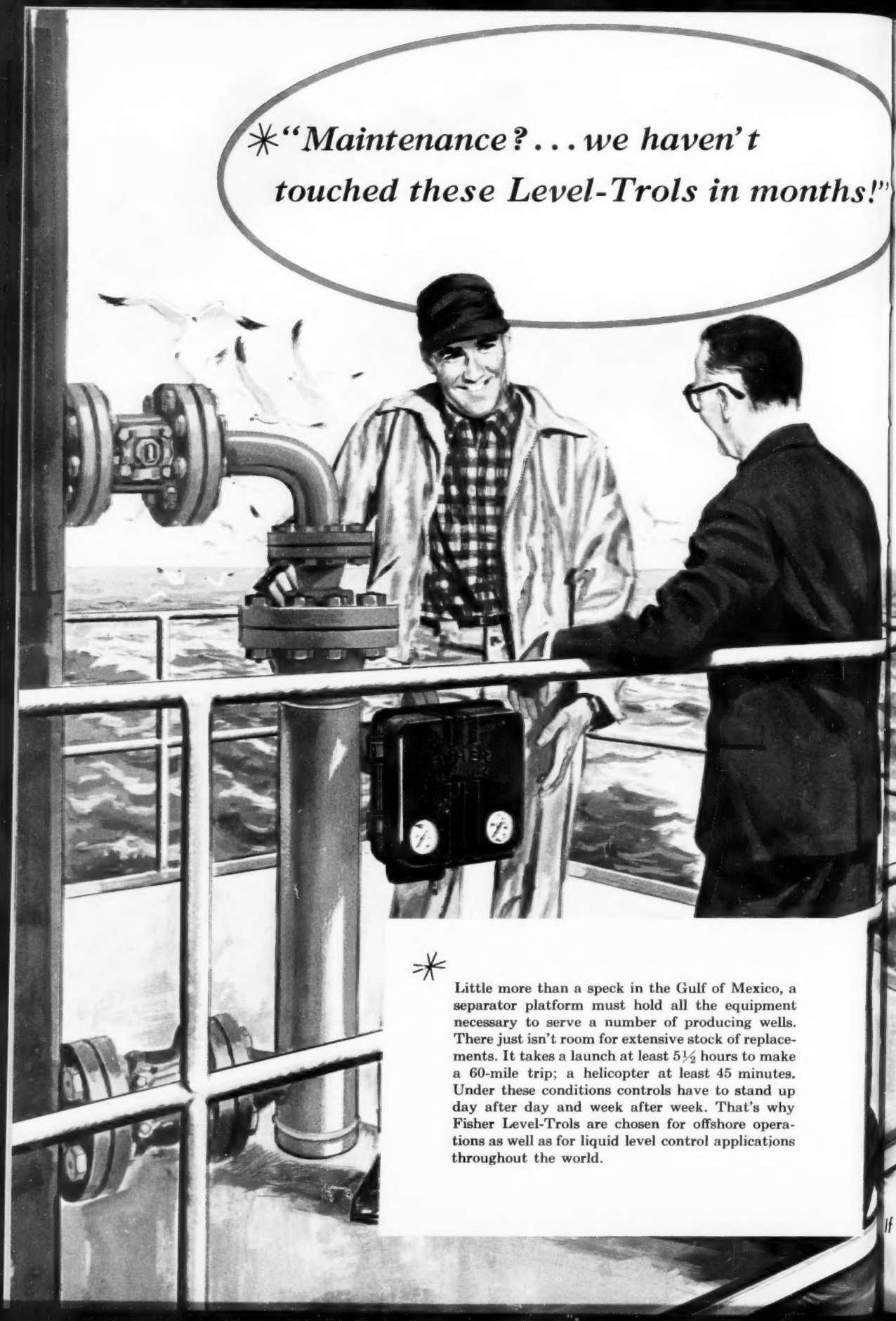


✳

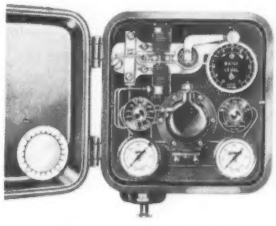
Little more than a speck in the Gulf of Mexico, a separator platform must hold all the equipment necessary to serve a number of producing wells. There just isn't room for extensive stock of replacements. It takes a launch at least 5½ hours to make a 60-mile trip; a helicopter at least 45 minutes. Under these conditions controls have to stand up day after day and week after week. That's why Fisher Level-Trols are chosen for offshore operations as well as for liquid level control applications throughout the world.

FISHER LEVEL-TROLS®

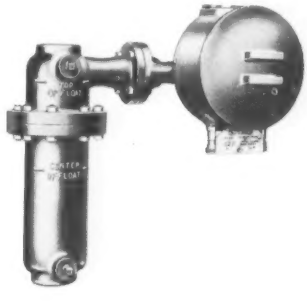
for accurate, trouble-free liquid level control on a wide range of applications....

THREE BASIC CONTROLLERS

THE POPULAR TYPE 2500 PROPORTIONAL CONTROLLER—This compact and economical liquid level controller provides a proportional band adjustment up to 100%. It is pneumatically operated and level position is manually adjustable for quick, simple selection of set point. The 2500 is suitable for 3 to 15 psi or 6 to 30 psi output ranges. Controller action easily reversed in the field. Available in all styles of mountings and housings and in displacer lengths 14″ through 120″.



TYPE 2502 PROPORTIONAL RESET CONTROLLER—This Level-Trol includes, in the same size case, all the features of the Type 2500, plus reset action. It, therefore, brings the set point back, automatically to its original position and assures absolutely stable control. Proportional band adjustable to 200% and reset rate is adjustable from .005 to 1 minute per repeat.



TYPE 2300 ELECTRONIC CONTROLLER—Explosion-proof design for hazardous locations. External adjustments for proportional band (10 to 100%) and liquid level set point. Mounts on standard Level-Trol housings. Available for output DC signals 1 to 5 ma, 4 to 20 ma or 10 to 50 ma. Has plug-in converter with printed circuit. For more information on Fisher Level-Trols write to:

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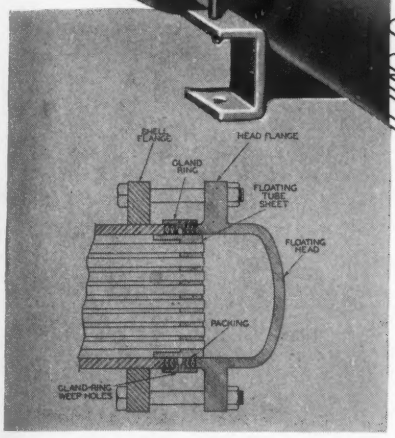
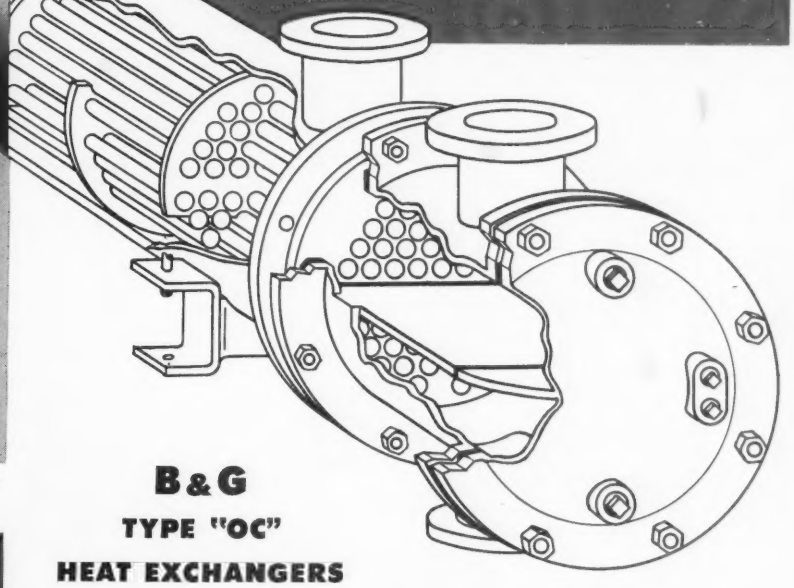


Cross section of Type "OC" Heat Exchanger showing floating head construction.

B&G Heat Exchangers are welded in specially designed fixtures by expert workmen.

All B&G Heat Exchangers are built to A.S.M.E. Code requirements and are so stamped.



B&G TYPE "OC" HEAT EXCHANGERS

For heating or cooling a wide variety of liquids and gases, "OC" Heat Exchangers offer numerous design and construction features which are a warranty of long life and efficient performance.

These units have removable tube bundles with an internally packed floating head. Sizes range from 6″ through 30″ diameters, lengths from 2′ through 20′. Standard material includes steel shells and tube sheets, cast iron heads and copper tubes. Stainless steel tubes, tube sheets and heads are also available. The design of "OC" exchangers may be varied for channel or bonnet heads in both single and two-pass construction.

B&G "OC" Heat Exchangers are not only engineered to top efficiency but are constructed to the uncompromising standards of quality and safety demanded by the A.S.M.E. Code.

With each B&G "OC" Exchanger, a Manufacturer's Data Report for Unfired Pressure Vessels, Form No. U-1, as required by the A.S.M.E. Code rules, is furnished. This form is signed by a qualified inspector, holding a National Board Commission, certifying that the construction conforms to the latest A.S.M.E. Code for unfired pressure vessels. The A.S.M.E. "U" symbol is stamped on each exchanger.

These exchangers are custom-designed units, built to your specifications. Inquiries are invited.

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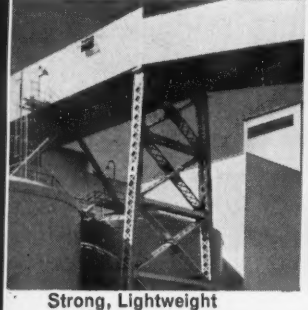
Strong, lightweight, corrosion-resistant Reynolds Aluminum Process Pipe costs no more than galvanized pipe, when installation and shipping costs are considered. Yet, it offers many advantages over ordinary pipe: it won't rust; it handles a long list of corrosive fluids without contamination, without loss of strength, without staining; its light weight can cut shipping and installation costs.

Reynolds Aluminum Pipe is easy to handle, cut, form, bend, thread, couple, and weld. Reynolds offers a full range of diameters and wall thicknesses in standard aluminum pipe and tubing, Heavy-End Pipe, steam trace (Duplex) pipe, and instrument tubing. For complete literature file, call your local Reynolds office, or write *Reynolds Metals Company, P.O. Box 2346-CJ, Richmond 18, Virginia.*

REYNOLDS ALUMINUM FOR CHEMICAL PROCESSING



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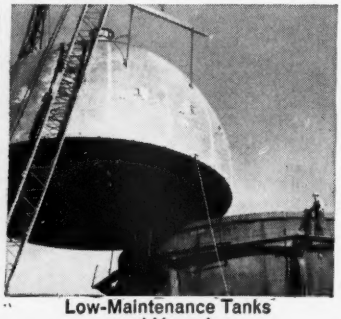
Clean, Low-Maintenance Jacketing



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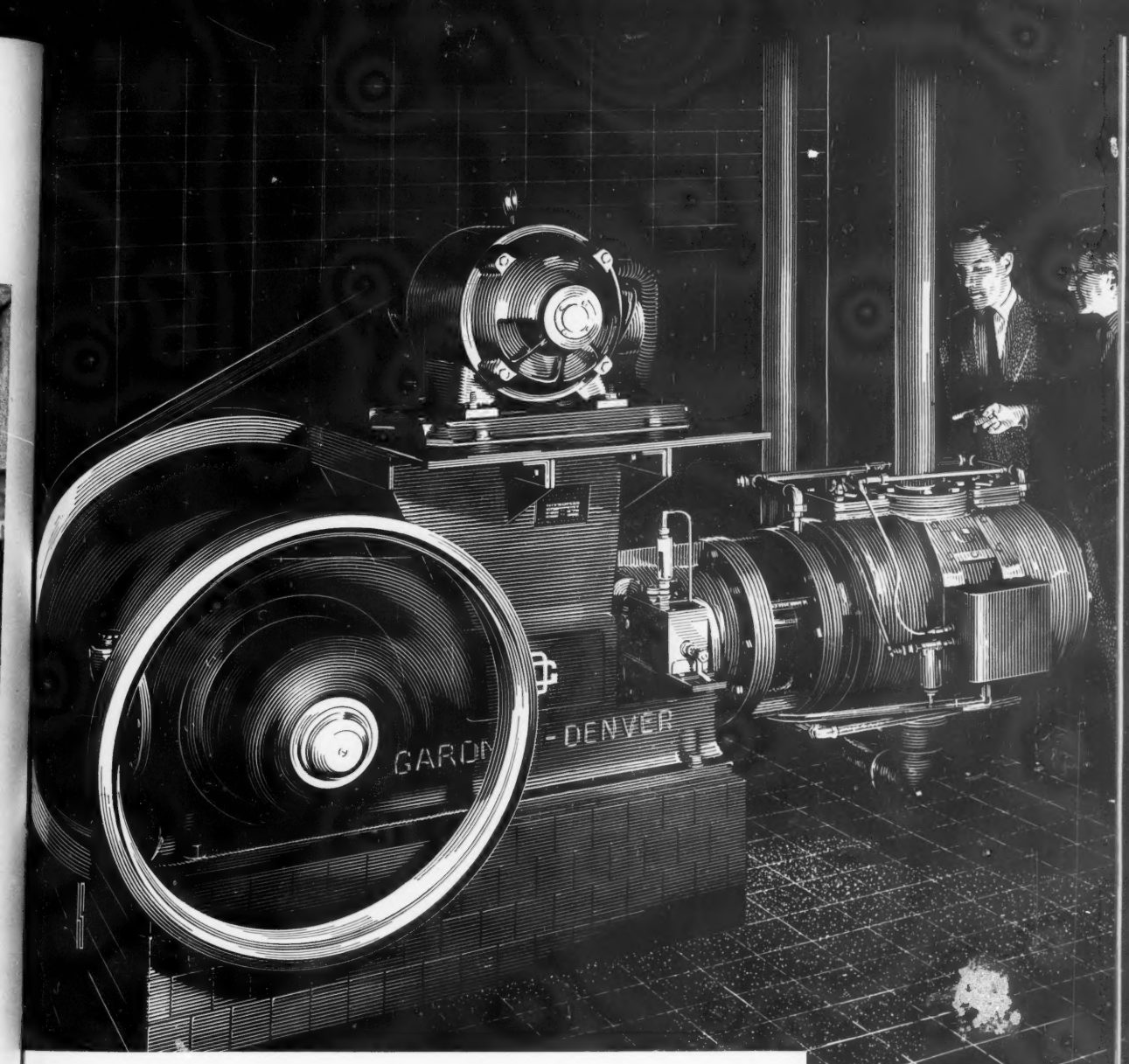

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. . . the reaction to Gardner-Denver oil-free compressors. They protect product quality by delivering pure, clean air—air that never has a drop of oil in it. So if even a trace of oil in your air line is too much, see Gardner-Denver first. Write for bulletin CRC-10.

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An outstanding line of LOUIS ALLIS adjustable-speed drives from ½ to 2500 hp.

Louis Allis offers you a complete line of adjustable-speed drives with various characteristics for every application where adjustable speed is required.

Experienced Louis Allis field engineers, supported by regional and factory industry specialists, will help you select the best drive or drive system to meet *your* requirements.

The Louis Allis line of drives provides outstanding control features ranging from simple manual to precise electronic or transistorized control. Selection of control varies, of course, with the nature of the installation and the precision required. Where desirable, speed regulation as close as .1% is obtainable.

Controls can be provided which automatically respond to temperature, pressure, or flow. Other control features include threading, inching, jogging, logarithmic acceleration, torque-limit acceleration, tachometer feedback... and many other control provisions that can exactly tailor a Louis Allis drive to *your* operation.

For process plants or applications involving inter-related motors and multiple drives, Louis Allis engineers can provide complete "systems engineering," furnishing all electrical rotating components and control.

For expert assistance, call your local Louis Allis District Office listed in the Yellow Pages under "Electric Motors"... or write direct to The Louis Allis Company, 447 East Stewart Street, Milwaukee 1, Wisconsin. Ask for Bulletin 2900, "Louis Allis Adjustable Speed Drives."

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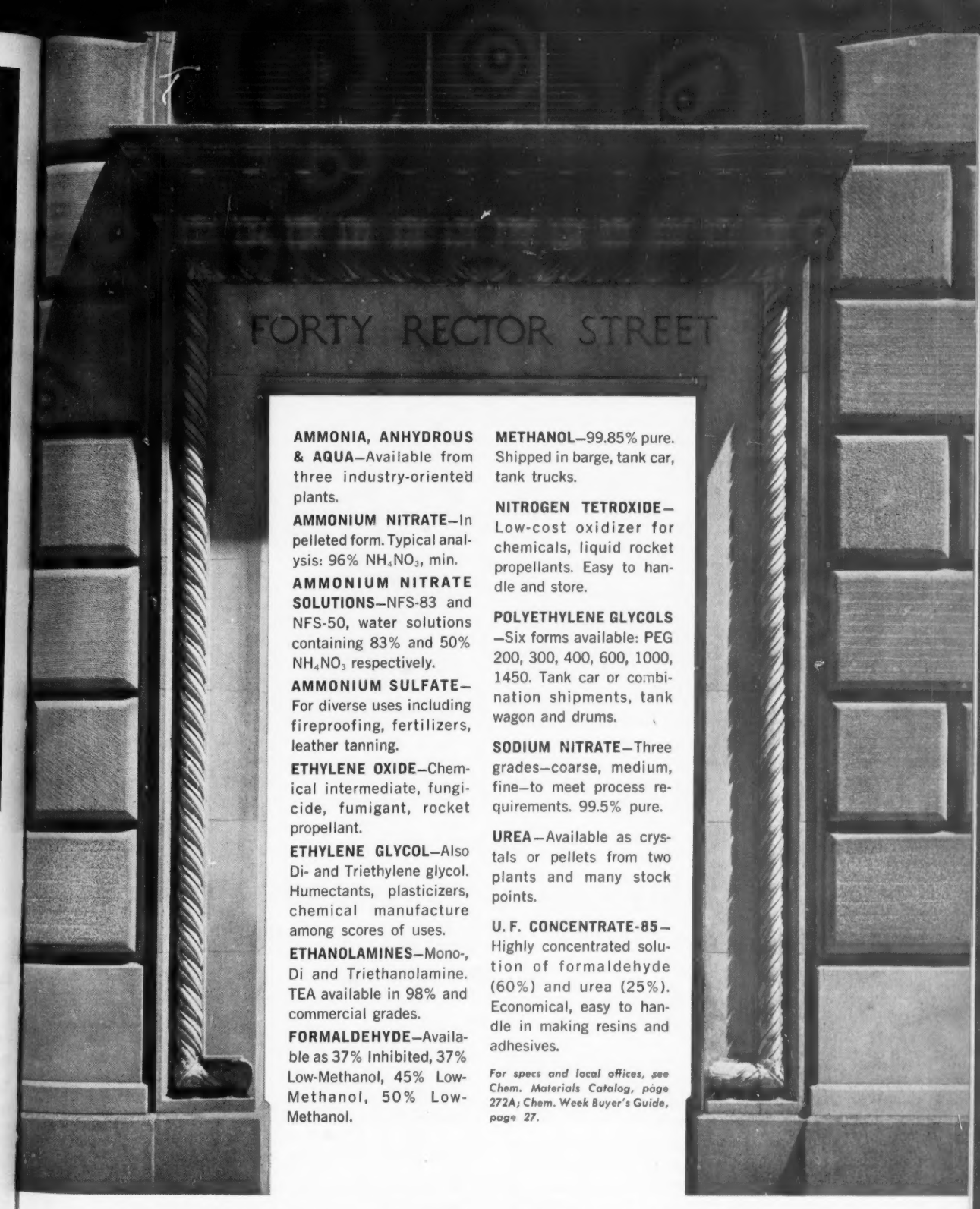

AMMONIA, ANHYDROUS & AQUA—Available from three industry-oriented plants.

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AMMONIUM NITRATE SOLUTIONS—NFS-83 and NFS-50, water solutions containing 83% and 50% NH_4NO_3 respectively.

AMMONIUM SULFATE—For diverse uses including fireproofing, fertilizers, leather tanning.

ETHYLENE OXIDE—Chemical intermediate, fungicide, fumigant, rocket propellant.

ETHYLENE GLYCOL—Also Di- and Triethylene glycol. Humectants, plasticizers, chemical manufacture among scores of uses.

ETHANOLAMINES—Mono-, Di and Triethanolamine. TEA available in 98% and commercial grades.

FORMALDEHYDE—Available as 37% Inhibited, 37% Low-Methanol, 45% Low-Methanol, 50% Low-Methanol.

METHANOL—99.85% pure. Shipped in barge, tank car, tank trucks.

NITROGEN TETROXIDE—Low-cost oxidizer for chemicals, liquid rocket propellants. Easy to handle and store.

POLYETHYLENE GLYCOLS—Six forms available: PEG 200, 300, 400, 600, 1000, 1450. Tank car or combination shipments, tank wagon and drums.

SODIUM NITRATE—Three grades—coarse, medium, fine—to meet process requirements. 99.5% pure.

UREA—Available as crystals or pellets from two plants and many stock points.

U. F. CONCENTRATE-85—Highly concentrated solution of formaldehyde (60%) and urea (25%). Economical, easy to handle in making resins and adhesives.

For specs and local offices, see Chem. Materials Catalog, page 272A; Chem. Week Buyer's Guide, page 27.

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Allied Chemical

BASIC TO AMERICA'S PROGRESS

NITROGEN DIVISION

Dept. AP12-5-1, 40 Rector Street, New York 6, N.Y.

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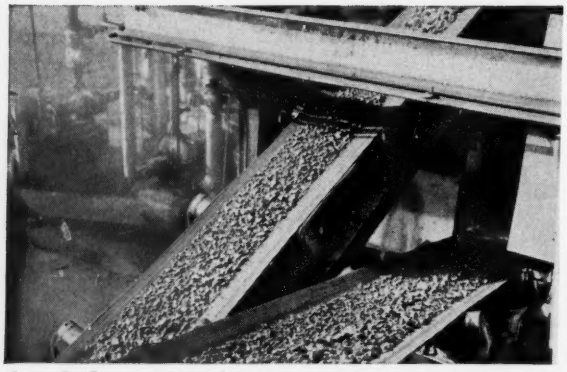
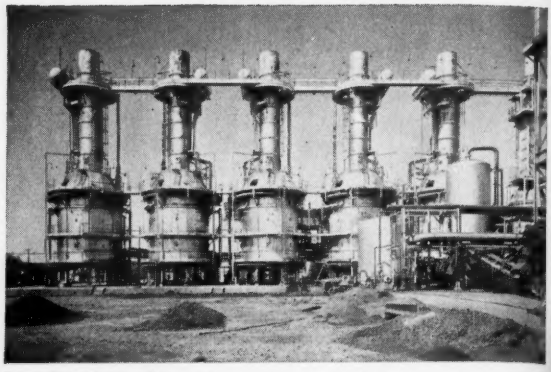
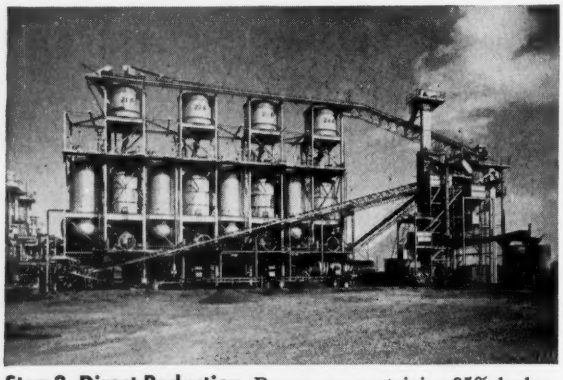


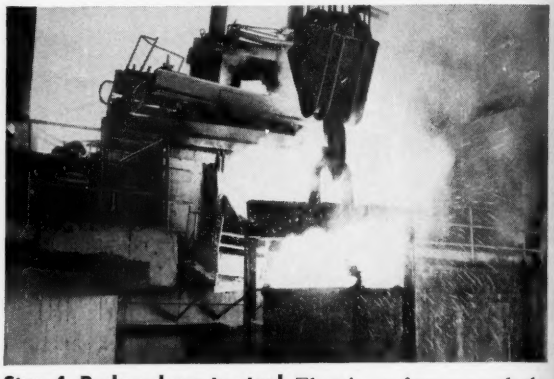
Step 1. Ore preparation. First step in Sponge Iron Process starts with Pihuamo and Durango ores being crushed and screened to ¼-1½ inch sizes. Ore is then poured into batch-type reactors. Some ores are first roasted to lower sulfur content.



Step 2. Natural gas is converted into hydrogen by catalytic steam reforming. After pre-heating and mixing with steam, the gas flows through heat-resistant Incoloy alloy tubes, which are heated to temperatures of 1400° to 1800°F.



Step 3. Direct Reduction. Process gas containing 85% hydrogen passes through reactors loaded with ore, removing 90% of the oxygen and 85% of any sulfur present. Reduced product averages 85% metallic iron, 15% iron oxide.



Step 4. Reduced ore to steel. Electric-arc furnaces melt the reduced ore to steel. The rimming and low-carbon steel ingots produced are exceptionally free of contaminants and have excellent qualities when converted to steel products.

Producing hydrogen for new iron ore reduction process...

Incoloy alloy tubing withstands furnace temperatures of 1400° to 1800° F

A new chemical process makes possible economical steel production by direct and continuous reduction of ore to sponge iron.

Developed by Hojalata y Lamina S. A., a leading Mexican steel producer, with engineering assistance from the M. W. Kellogg Co. of N. Y., the process involves the reduction of iron ore by hydrogen gas.

Steam-Methane Reforming is used to produce the all-important hydrogen. In the high temperature process, feed-gas—in vertically suspended tubes—is mixed with steam and heated at temperatures of 1400° to 1800°F. Operating pressures run as high as 125 psig.

To meet these demanding service conditions, extruded tubing of Incoloy* nickel-iron-chromium alloy was specified because of these specific advantages:

- Strength at elevated temperatures
- Resistance to a wide range of corrosives
- Resistance to oxidation and carburization
- Good weldability
- Freedom from sigma phase formation. In critical 1,100 to 1,600°F range, Incoloy alloy retains its ductility and impact strength.

If the selection of furnace tube materials is your responsibility, detailed information on the advantages of Incoloy alloy is yours with the helpful booklet, "Incoloy Extruded Tubing in the Petrochemical Industry." Just write to:

*Inco trademark

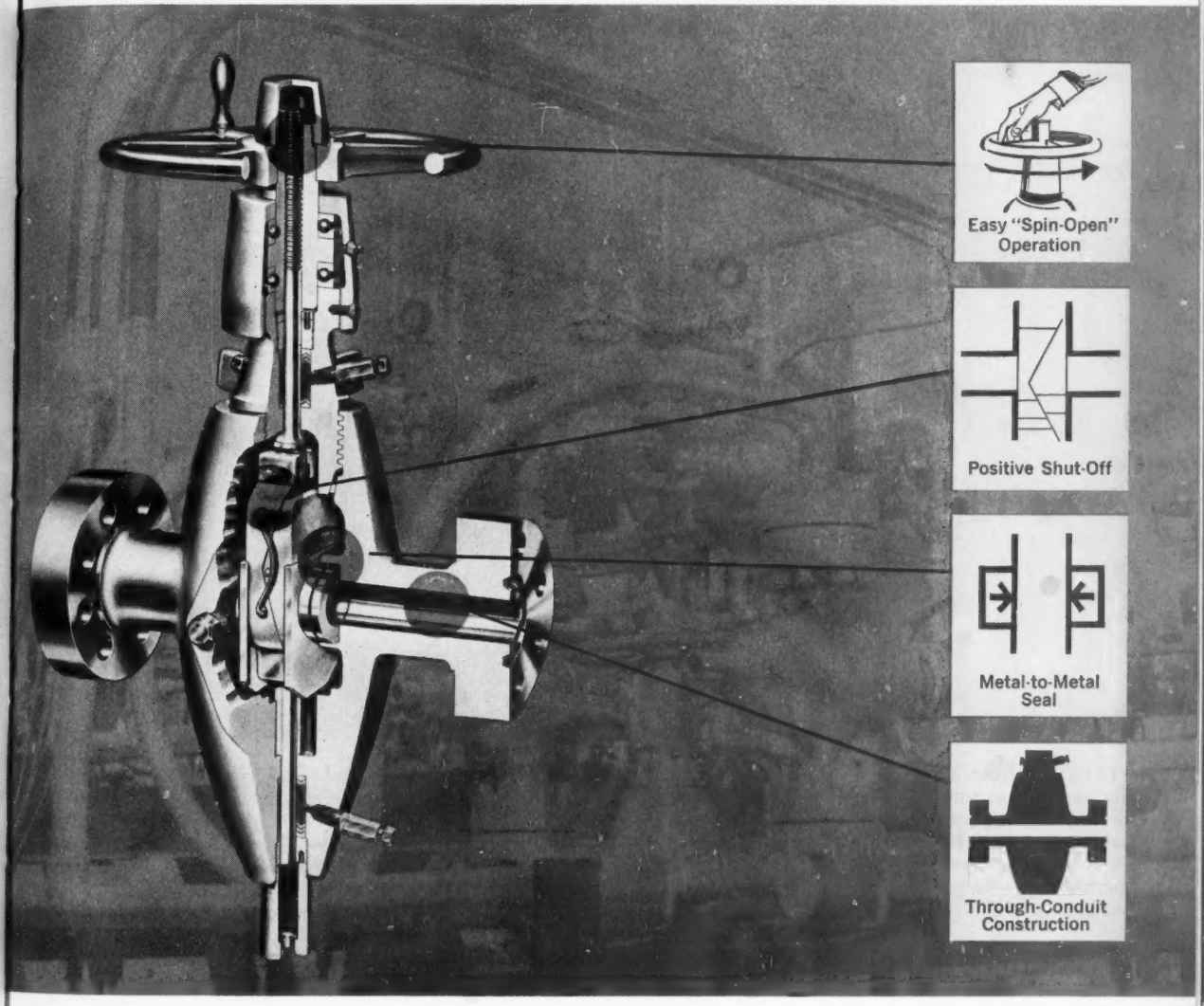
INCOLOY®

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia

FOR SUPER-PRESSURES...20,000 PSI PLUS
W-K-M Through-Conduit Gate Valves

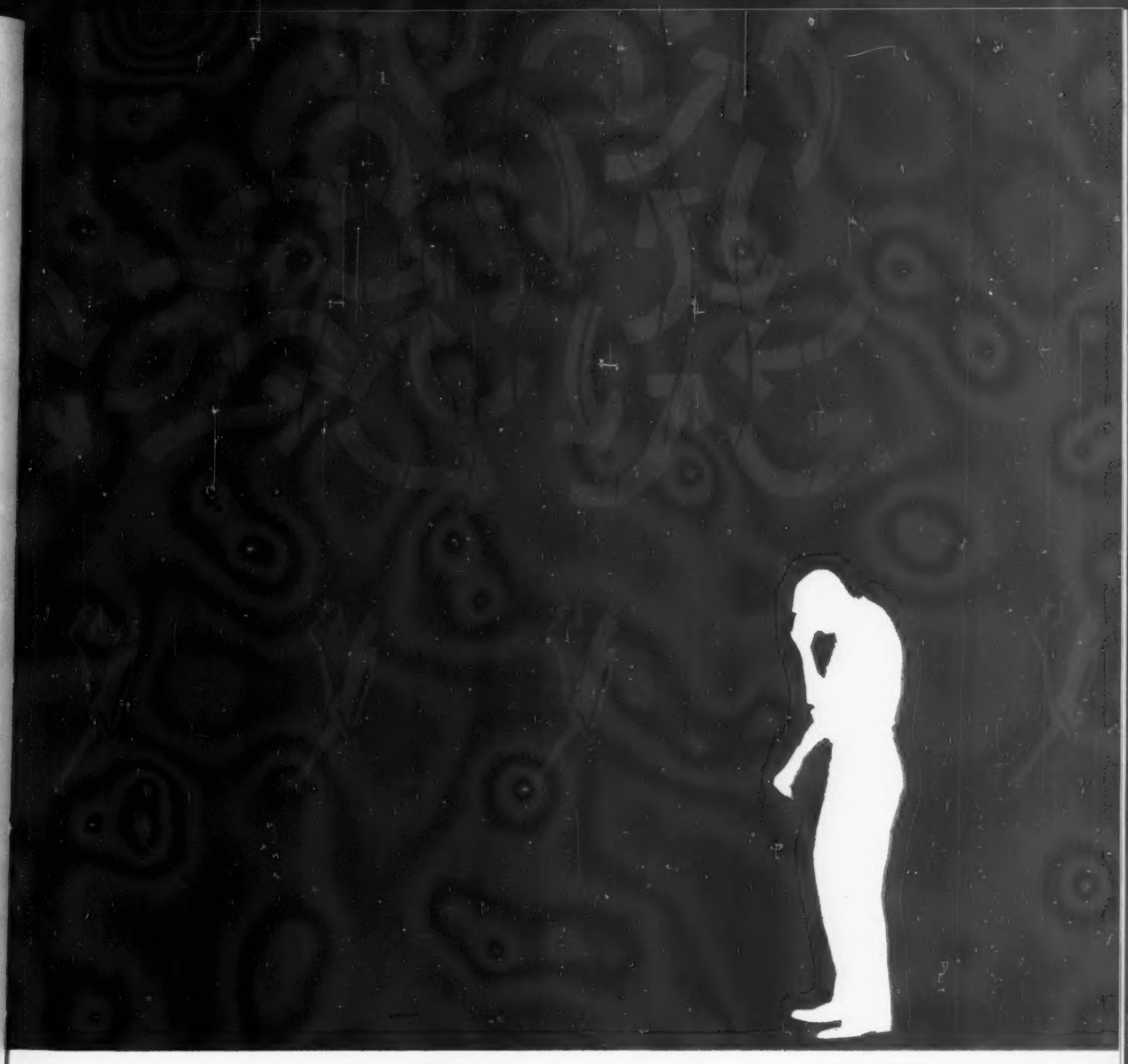
When you need a valve up to 2 - 9/16″ bore, with a perfectly smooth through-conduit passage—no cavities and no projections—capable of a total seal up and downstream, specify W-K-M Through-Conduit Balanced Stem Gate Valves. No other valves can control high-volume products at super-pressures as efficiently and positively as these. The double-wedge parallel-expanding gate makes a dead-tight mechanical seal in either open or closed position. A bottom stem cancels out stem thrust for spin-open, spin-shut operation. These are the easiest-operating high-pressure valves ever made. Send for full information on W-K-M Through-Conduit Balanced Stem Gate Valves . . . P. O. Box 2117, Houston 1, Texas.

When So Much Depends on a Valve . . . Specify W-K-M.



W-K-M DIVISION

ACF INDUSTRIES



Problem: Lack of pep -- and people -- due to bad air

This plant needs make-up air! If production is off because your workers lack pep or become sick from bad air, check your exhaust system! Its fans may be removing air faster than you replace it. This causes a vacuum that can put your plant ventilation dangerously out of balance. Your plant needs make-up air...a supply of new air to replace exhausted air.

Without make-up air, the vacuum can cause down drafts in combustion flues and exhaust hoods, exposing workers to carbon monoxide and other dangerous fumes. Vitality sags. Absenteeism rises. Production drops.

Solution: install a make-up air system -- fans to bring in fresh outside air, and heaters to temper it. You cancel out the vacuum, ease the load on exhaust fans and the regular heating system. No ventilation plan is complete without make-up air.

For technical help on make-up air, see your Consulting Engineer. Or call in Sturtevant application engineers. They're experts in handling air...whether you want to move it, heat, cool or clean it. J-80710

WESTINGHOUSE ELECTRIC CORPORATION
Sturtevant Division, Dept. GD-10.
Hyde Park 36, Mass.

Send me your make-up air booklet.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

PHONE_____

You can be sure...if it's **Westinghouse**

ONE OF A SERIES OF CHATS ABOUT CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

A FAMOUS FLUID WITH TEMPERATURE CONTROL PROBLEMS

Wine has never been properly appreciated by enough people. Many think you simply press grapes, bottle the juice, and wait a while to create wine. Even those who pride themselves on their knowledge of this age-old drink are seldom aware of the artful thermal engineering required. Pasteurizing wine is actually one of the most tricky and delicate feats in the field of liquid processing.

Take temperatures. Wine must be pasteurized at 140°F. Those are the facts of life in the world of wine. They might not seem too difficult to live with unless you're in the wine or chemical processing business.

Take New York's Monarch Wine Company, producers of Manischewitz Wine. Their Problem: how to maintain the 140° temperature in the heat exchangers despite wide variations in the rate of wine flow. These variations, between 5 to 60 gallons per minute, result from slowdowns and recoveries in the bottling process. Problem: entire system must be capable of complete shutdown when necessary. Problem: wine temperatures must be raised to 140° as rapidly as possible, sometimes an immediate jump of 100°

Attracted perhaps by aspects of the situation that had little to do with pure science, Sarco engineers applied the collective experience of Sarco technology to the solution of this serious problem. The result for Monarch: the *degree of control* the process demanded—achieved through the excellent use of Sarco Temperature-Pressure Regulators, Float Thermostatic Steam Traps, Thermo-Dynamic Steam Traps, and Pipeline Strainers.

Sarco engineers, ever resourceful, divided each of the two large Cherry-Burrell plate-type heat exchanger units into two separate sections with a blank baffle plate, each with a separate Sarco control. Thermal sensing bulbs were installed in wine discharge and throttling controls hooked into steam supply. As demand fluctuates, one or both regulators function to maintain the 140° temperature.

In higher demand, both regulators are operative; as demand drops and flow decreases, only one regulator supplies steam. Pasteur himself would have been elated.

Each of six smaller capacity shell-and-tube heat exchangers required only one regulator, with the sensing bulb inserted into the outlet side of the wine filled shell, and the regulator throttling steam supply to the tube section. Thus, by controlling flow of steam to the exchangers on the basis of pressure and temperature, the Sarco regulators were able to maintain the temperature of the wine at precisely 140° regardless of fluctuations in demand or supply rate. Whew! A lot of engineering went into those two sentences.

From here on it's downhill. To secure complete cut off of the steam supply during scheduled shut-downs of the bottling run, solenoid valves were provided to supplement normal modulating action of the controls. To discharge widely varying loads of condensate continuously and remove immediately all air and incondensible gases, Sarco Float Thermostatic Steam Traps were installed on all condensate outlets. On the drips before each control valve a Sarco Thermo-Dynamic Steam Trap was installed to insure delivery of dry steam. Sarco Pipeline Strainers were installed before all steam traps and valves to protect them against damage by any foreign bodies. And thus ends a classic story of the grape.

Still, this story has been condensed far too much, really, and we feel you've been cheated out of the story's more delicious details. You needn't be, however. We've printed the facts in detail for posterity and you in Sarco Case History 185, complete with drawings that practically make it a do-it-yourself kit. If you would like a copy, we will be flattered to receive your request, and dispatch it with dispatch.

WE'RE ALWAYS IN . . . AND THE WELCOME MAT'S OUT

We always take it for granted that if you are going to be in the vicinity of our plant you'll phone or drop us a line so we can invite you to visit us. You'll find that our factory in Bethlehem, Pennsylvania, is on many well-travelled routes and that our steam laboratory has much to offer in interest and helpfulness. Forgive us for being immodest, but the lab is the most up-to-date of its kind in the country.

When you visit us, don't allow yourself to get sidetracked by the drill presses and automatic lathes. We're proud of this equipment but you've probably seen metal mutilated before, and it's our steam laboratory that's unique. We promise you a good show, and if you have any problems, bring them along. We'll solve them while you wait.

ANYONE FOR KEY CHAINS?

We seem to have these key chains. Want one? They're much more convenient than a case. A tiny replica of a Sarco Thermo-Dynamic Steam Trap, Type TD-50 is attached, but you can always remove it if you find it too commercial. There must be many things you could use these chains for. Fishing sinkers? Lengthening a light cord, maybe? Anyway, if your Sarco representative is out, write in.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate.

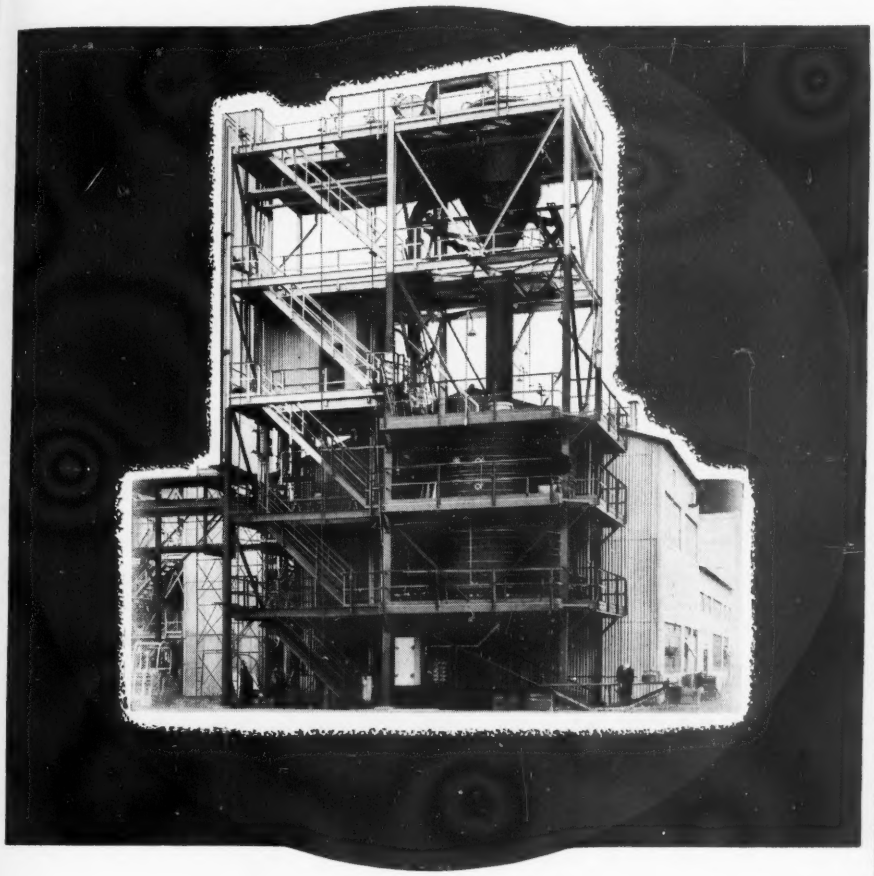
6354

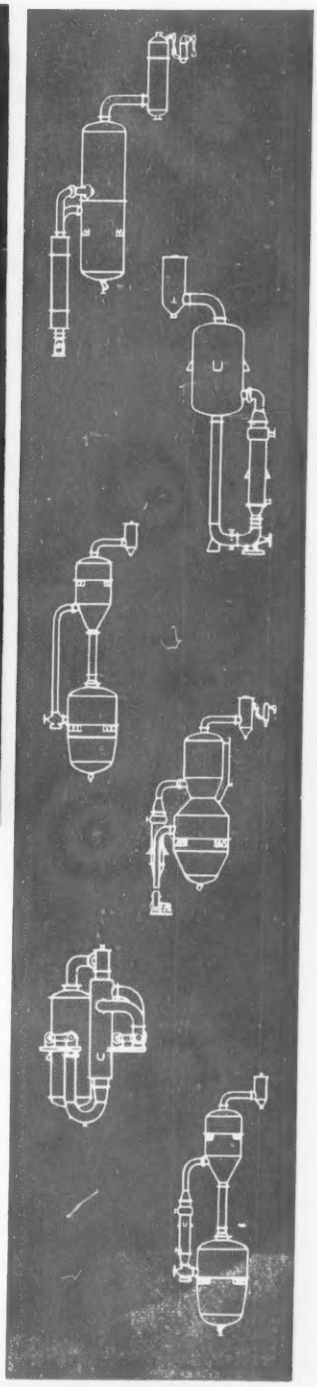
SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

HOW TO SAVE MONEY WHEN BUYING
crystallization equipment





■ Consider more than initial cost

Economy in selecting crystallization equipment involves more than purchase price. There are operating costs . . . steam costs . . . product purity . . . uniformity of crystal size . . . separation of crystals and mother liquor . . . reduction of wash water . . . dryer operation and many other factors.

■ Consult with Crystallization specialists

Struthers Wells has long engineering experience in this field, as well as manufacturing know-how, research laboratories, pilot plant equipment and production facilities.

■ Tailor-made equipment saves time and money

Trained crystallization specialists at Struthers Wells are fully qualified to review your requirements and recommend a crystallization package with modifications which are *tailor-made to meet your exact needs* in the most economical way. Write us for complete details.

Struthers Wells

STRUTHERS WELLS CORPORATION

WARREN, PA.

Plants at Titusville, Pa. and Warren, Pa.

Another Cooper-Bessemer centrifugal goes to work

Here's proof of compressor economy

When your plans call for centrifugal compressors, it will pay you to be guided by the experience of others. Take a tip from the *repeat order* record of Cooper-Bessemer centrifugals as a sure sign of *cost-saving performance.*

The Cooper-Bessemer centrifugal shown here is being shipped to a chemical manufacturer for big volume compression. They *know* how reliable C-B centrifugals really are. Another unit has been operating there 'round-the-clock for two years, as part of a process, where constant availability is a *must.*

Repeat orders for Cooper-Bessemer centrifugal compressors have come time and again from many progressive companies.

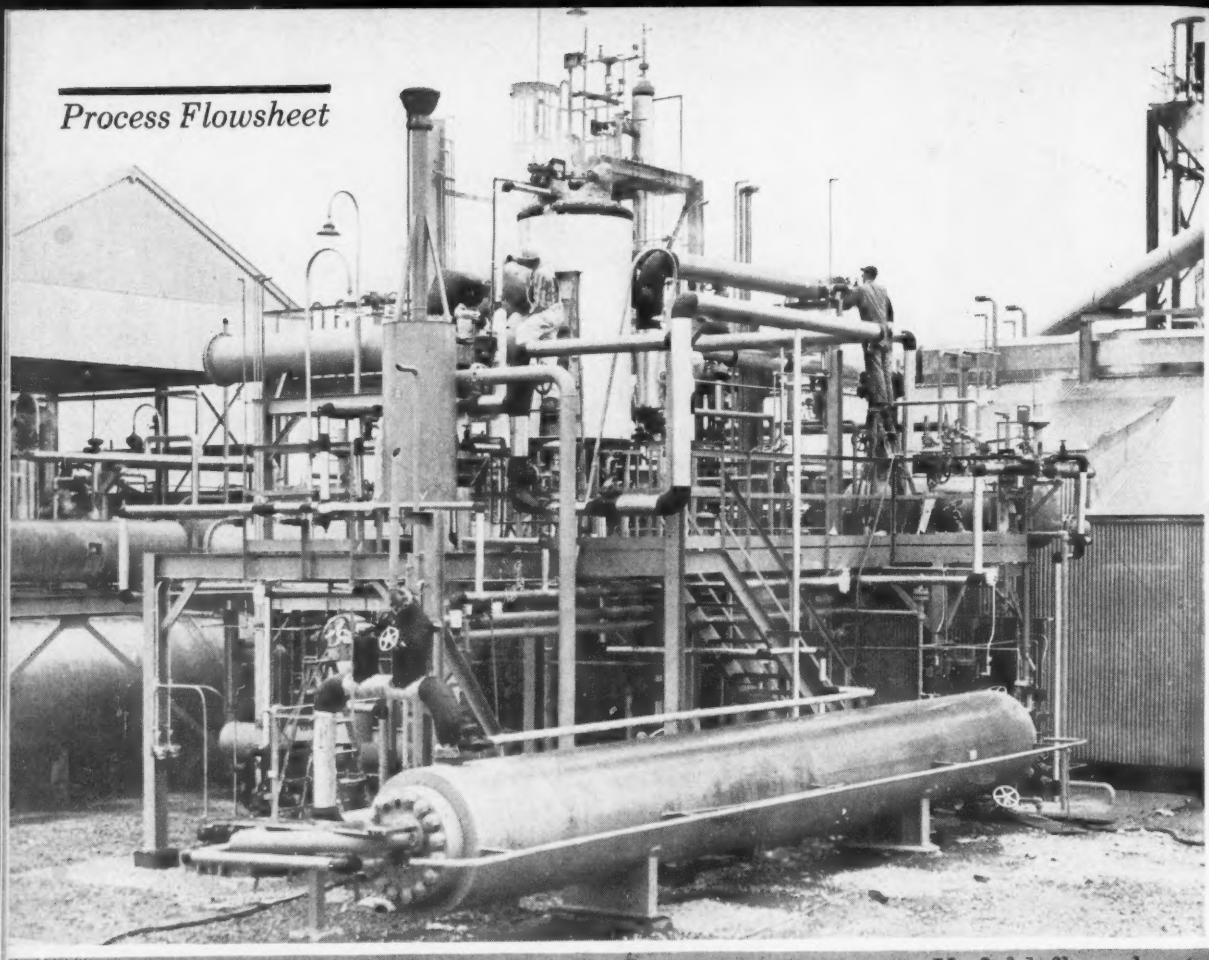
Many features account for the stamina and dependability of Cooper-Bessemer centrifugal compressors—such as their rugged all-welded impellers, and unique shaft sealing. Find out how they can pay off for *you.* Call our nearest office or write . . .

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINES: GAS • DIESEL • GAS-DIESEL
JET-POWERED GAS TURBINES

Process Flowsheet



Horizontal autoclaves involved lower initial costs than do the usual vertical vessels. Unfold flowsheet

Fresh Ideas Improve Urea Process

Urea's fast-growing status as a fertilizer has triggered new advances in the production technology for this historic organic. Among the latest of urea flowsheets is the one described here.

N. P. CHOPEY, *Assistant Editor*

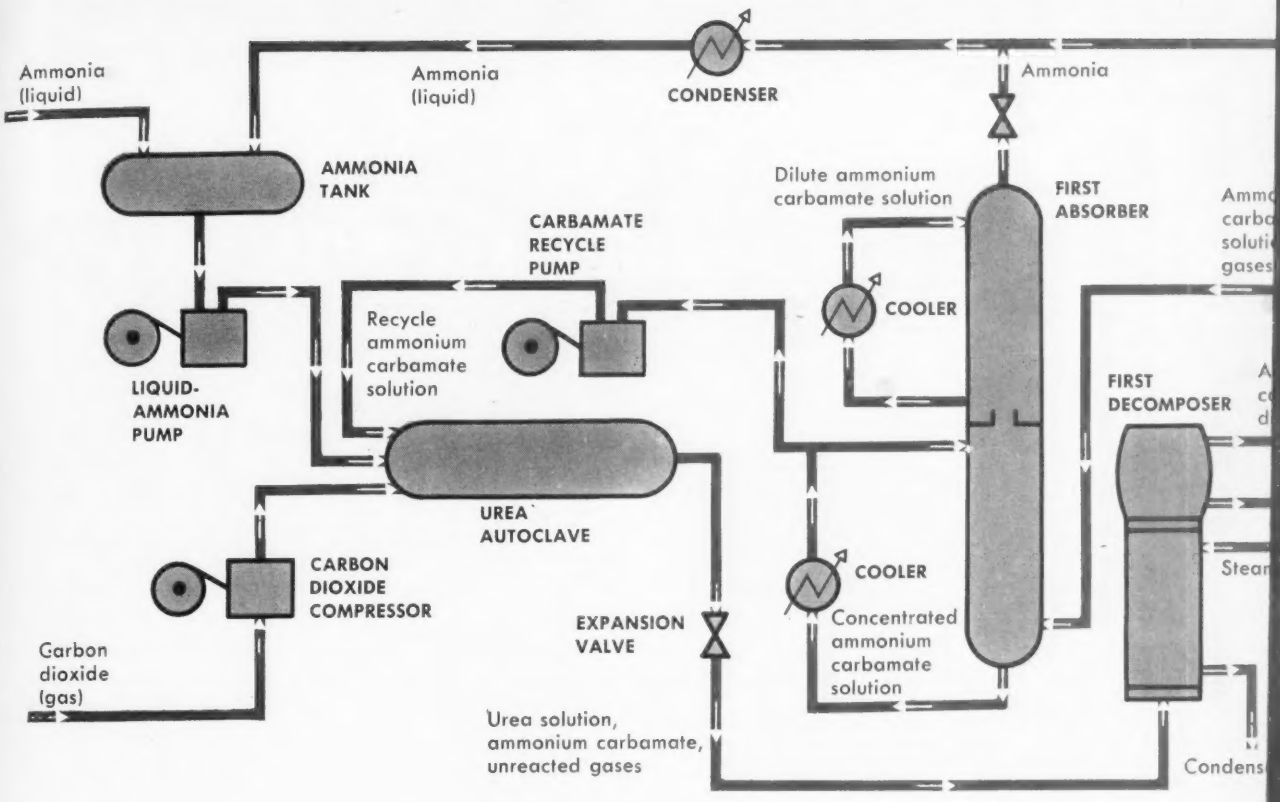
The past decade has seen urea, long known mainly for its historic connection with the beginnings of organic chemistry, rise into prominence as a nitrogenous fertilizer. And with this growth has come a profusion of new flowsheets, each adding its own refinements to the basic urea process.

Cooperative Farm Chemicals Assn.'s urea plant at Lawrence, Kan., provides a good, recent example. Designed and built by Chemical Construction Corp., New York, its process incorporates novel and simple approaches to some of the problems of economic urea production.

The unit went on stream in October 1959 with a design capacity of 30 tons/day; an expansion completed late last year has upped this figure by two thirds. Predominant material of construction throughout the plant is stainless steel.

▶ **Making Urea**—All known urea processes follow two basic steps: ammonia and carbon dioxide react at high temperature and pressure to form ammonium carbamate, then the latter dehydrates to produce urea and water.

$$2NH_3 + CO_2 = NH_2COONH_4$$
$$NH_2COONH_4 = NH_2CONH_2 + H_2O$$



The first reaction easily goes to completion but the second is incomplete under all practical conditions, carbamate-to-urea conversion being on the order of 40-60%. Both take place in a single autoclave, which is usually fed with excess ammonia. Urea is separated from the autoclave product stream by endothermically decomposing unconverted carbamate into a gaseous mixture of ammonia and carbon dioxide.

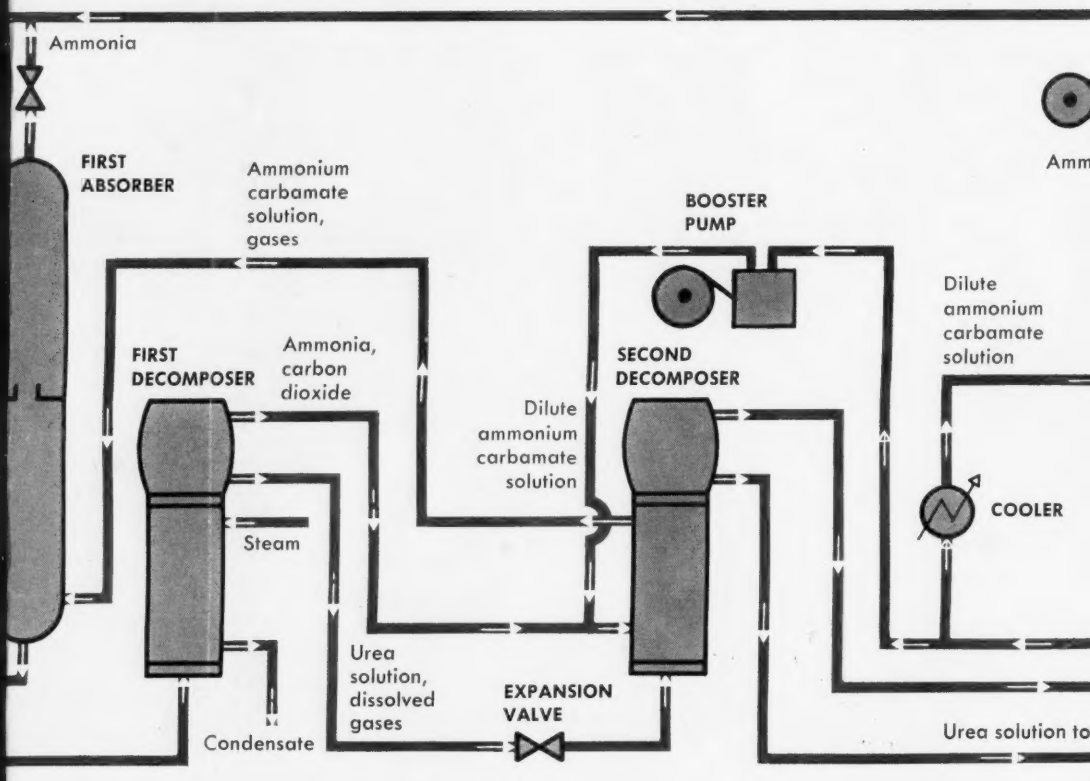
Most process refinements have been aimed at economic disposition of this mixture. Simplest procedure is to send it to nearby processing operations, but this isn't always possible or desirable. A second alternate is to recycle it for urea production. However, compression of the mixture to autoclave pressure is troublesome and must be carried out at high temperature to avoid carbamate formation in the compressor system.

The third alternate is to recombine at least part of the gases to form carbamate, then send the latter to the autoclave. This scheme cuts recompression costs but it, too, has its drawbacks: if carbamate is transferred in aqueous solution, the water introduced to the autoclave will lower urea yield; and if the carbamate is transferred nonaqueously (as in an oil slurry), the urea must be purified of the nonaqueous medium used.

▶ **A Look at Lawrence**—Chemico's approach at Lawrence is based on the use of minimum water —just sufficient to return all unreacted carbon dioxide as carbamate. Water is not used for recycling free ammonia; the latter is recovered as gas, then liquefied by heat exchange with cooling water.

With minimum water entering the autoclave, the urea yield is high. Accordingly, product solution is more concentrated, and evaporation costs are correspondingly lowered for plants that produce urea prills.

Heat economy is another key feature at Lawrence. As in most other processes, the plant employs two-stage decomposition of carbamate. In Chemico's design, steam requirements for decomposition are significantly cut by exothermically mixing dilute carbamate solution with ammonia and carbon dioxide. This mixing takes place on the heat-source side of the second decomposer, the gases coming from the first decomposer.



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Chemico cites the following utilities requirements per short ton urea for a plant using its complete-recycle process and turning out prilled product:

Electricity ..... 165 kwh.
Steam (150 psig., saturated) ..... 4,000 lb.
Cooling water (20 F. rise) ..... 20,000 gal.

▶ **Step by Step**—The plant feeds ammonia and carbon dioxide in a ratio of about 3.5 to 1. Dioxide enters the site at approximately 2 psig., is compressed to 3,200 psi. in a four-stage reciprocating compressor. It then goes to urea autoclaves, together with liquid ammonia and recycled carbamate solution.

An innovation at the Kansas facility is the use of horizontal autoclaves, which entail less investment and construction costs than do the conventional vertical vessels. They operate at 366-380 F., achieve about 60% conversion of carbamate to urea.

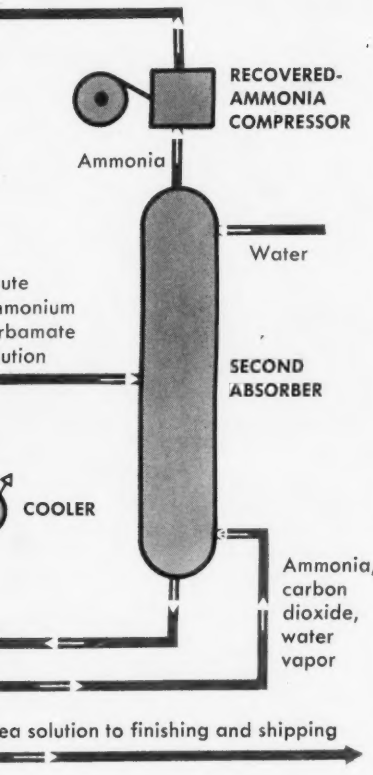
Effluent is lowered to about 300 psig., then goes to the tube side of a steam-heated, first-stage decomposer. Urea solution containing some dissolved ammonia and carbon dioxide leaves this vessel, is lowered to 15 psig. stage decomposer.

Product from the latter urea solution, ready for the p solutions. The plant does not

Each decomposer yields monia and carbon dioxide. N carbamate-recycle processes rectly to absorbers for carba at Lawrence the operation is

The gas from the seco does go to a second-stage abs around 15 psig. The overhead however, combines with dilut from the above-mentioned a enters the shell side of the where its exothermal mixin required for that vessel.

After giving up heat, th bottom of a first-stage absor psig. Carbamate recycles fro autoclave. Both absorbers overhead, the carbon dioxide streams being completely con



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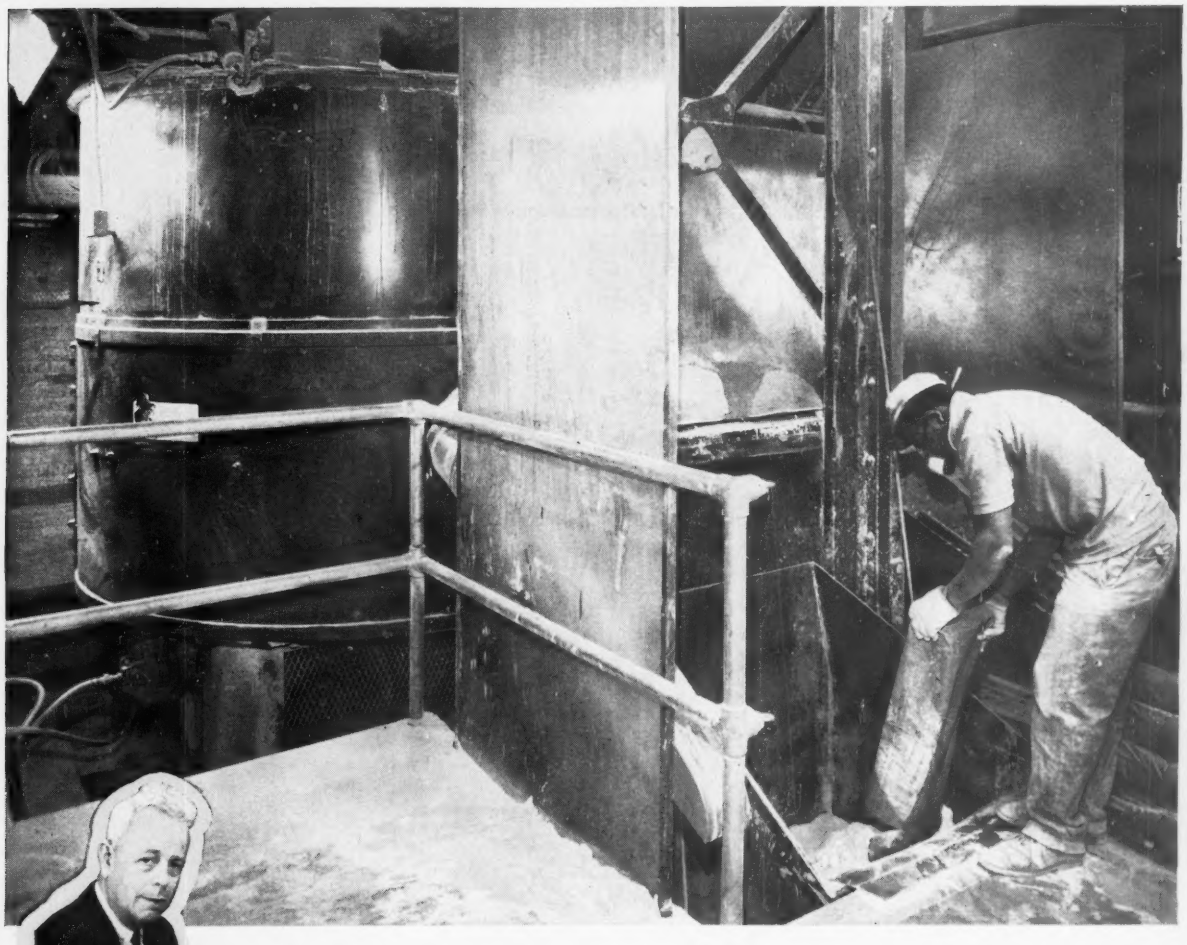
MIX-MULLER® means Controlled Dispersion



"This Mix-Muller helps us produce better tile in less time."

. . . John C. Elder, Factory Manager, Robertson Manufacturing Company, Morrisville, Pennsylvania

In October 1960, the Robertson Manufacturing Company, a large eastern tile manufacturer, replaced their continuous filter system with a dry mix system using a Model 3F Simpson Mix-Muller. In December, Mr. John Elder, Factory Manager, had these comments to make about the new installation:

"Incomparably" better moisture control

"The Mix-Muller system allows us to maintain moisture variation to within plus or minus .1%. This allows a better, cleaner die fill which has increased our press efficiency and has reduced pressing and firing rejects. Better moisture control has also permitted us to utilize the faster and more economical 'one-fire' method of operation."

Better utilization of manpower

"The old system operated seven days a week on a 3-shift basis. With the Mix-Muller, we are able to obtain the same production on a normal five day a week, 1½-shift work schedule . . . releasing manpower for other jobs."

Realize substantial space savings

"The Mix-Muller system occupies only ½ as much production space as the previous wet system. This releases floor space—which we intend to use for pneumatic handling equipment to charge the mixer."

In Summary . . .

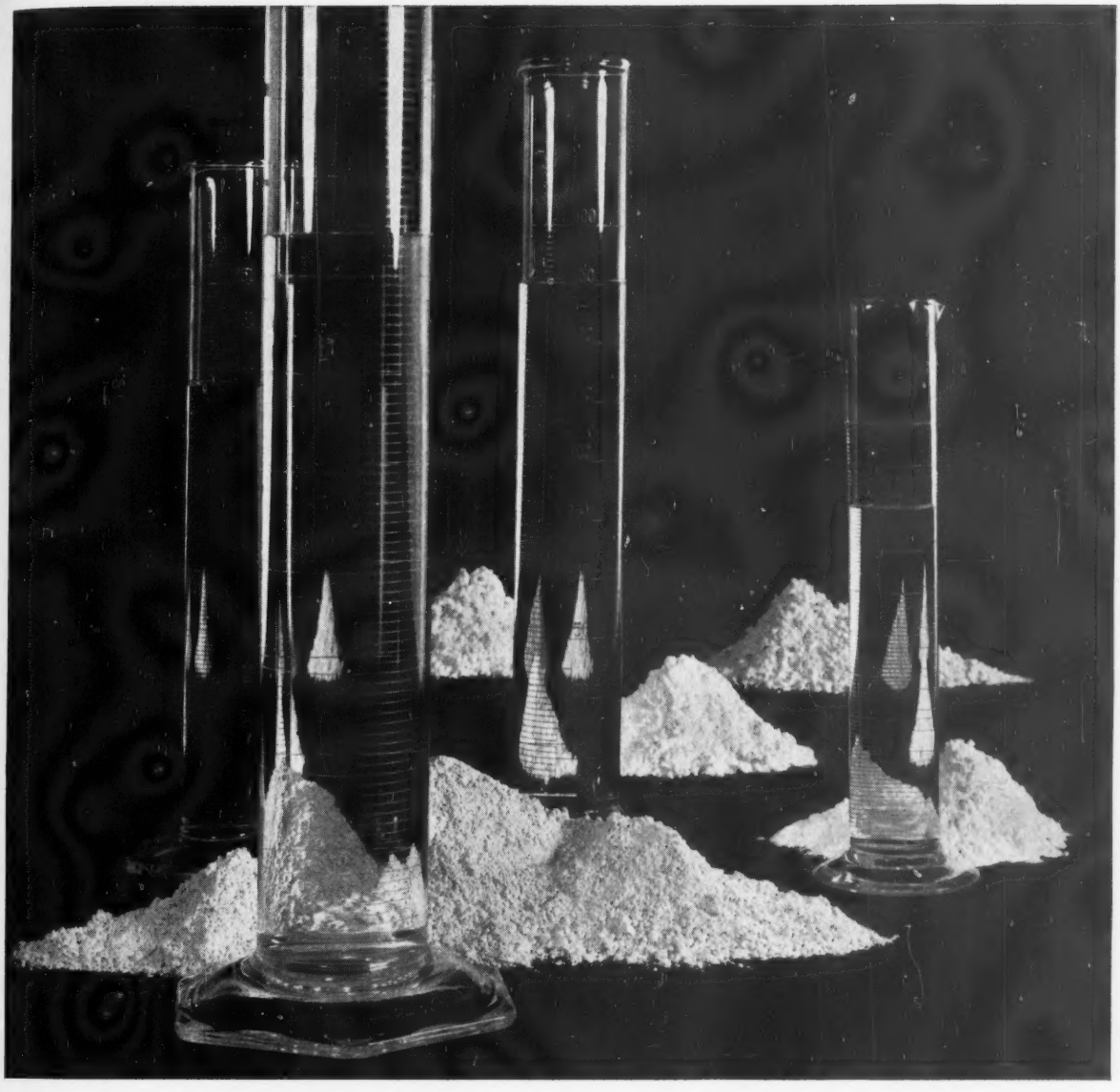
"The installation will pay for itself in reduced processing costs and increased production—notwithstanding the obvious benefits of vastly superior quality control."

If *you* mix dry or wetted solids, can you *afford* not to investigate how employment of *controlled dispersion* in a Simpson Mix-Muller can help you to attain (and we quote) *"vastly superior quality control . . . increased productive capacity . . . at less labor cost."*

See your National agent or write for the *Handbook on Mulling.*

P-261

SIMPSON MIX-MULLER® DIVISION
National Engineering Company
636 Machinery Hall Bldg. • Chicago, Illinois

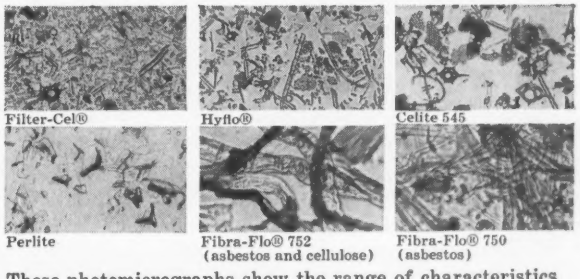


The right grade for every degree of clarity with Celite Filtration

For any filtration problem, there's a Celite® filter aid grade that gives you the exact degree of clarity desired at the fastest flow rate obtainable. Celite is available in many different grades, including special grades for specific applications. No other supplier gives you so wide a choice.

Celite's lower wet density means greater surface coverage, and its higher uniformity provides more consistent results from month to month, carload to carload, year after year.

For full details on how Celite gives the fastest, most efficient filtration at the lowest possible cost write: Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable: Johnmanvil.



These photomicrographs show the range of characteristics available with Celite filter aids.

JOHNS-MANVILLE

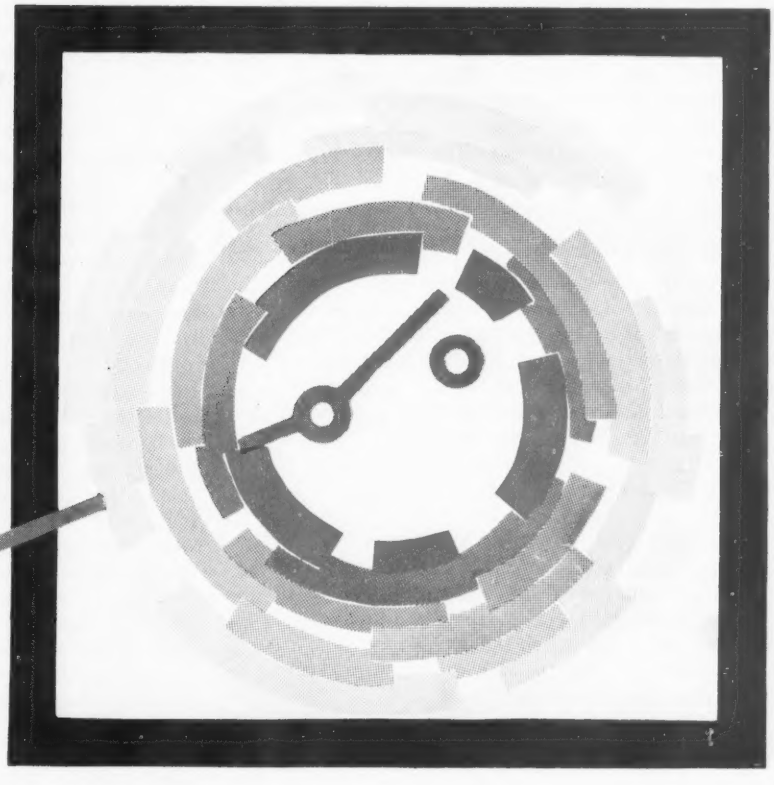
JOHNS-MANVILLE PRODUCTS

Today, the chemical process industries are dealing with more flammable and potentially explosive products than ever before. The continued growth of such CPI areas as petrochemicals, light metals and missile propellants means that the end of this trend is nowhere in sight.

At the same time, rapid advances in technology during the last few years have sharply increased the amount and variety of electric and electronic equipment used by the CPI.

Thus, we have a potent combination—more and more areas with potentially explosive atmospheres, and more and more electric equipment, control instruments, lighting fixtures, and so on, that must operate safely within them.

Electrical Safety Guide to Hazardous Process Areas



RICHARD W. SCOTT
Crouse-Hinds Co.

Electrical safety, therefore, is of crucial importance. The electrical installation must prevent accidental ignition of flammable liquids, vapors and dusts released to the atmosphere. In addition, since much of this equipment is used outdoors or in corrosive atmospheres, the material and finish must be such that maintenance costs and shutdowns are minimized.

The report that follows will, we hope, help achieve these objectives. We shall take up the classification of areas by degree of hazard; the selection, installation and maintenance of the proper electrical equipment; and new trends in wiring methods and materials.

Also, we shall suggest ways in which various agencies and equipment manufacturers can help improve or systematize the present safety practices in hazardous locations. These suggestions (as well as much other useful material) came about as a result of extensive interviews with engineers in many CPI plants.

FACTORS THAT DETERMINE DEGREE OF HAZARD

Combustion Principles

Three basic conditions must be satisfied for a fire or explosion to occur:

- A flammable liquid, vapor or combustible dust must be present in sufficient quantity.
- The flammable liquid, vapor or combustible dust must be mixed with air or oxygen in the proportions required to produce an explosive mixture. In other words, an explosion will only occur within a certain composition range.
- A source of energy must be applied to the the explosive mixture.

In applying these principles, the quantity of the flammable liquid or vapor that may be liberated and its physical characteristics must be recognized. For instance, lighter-than-air gases diffuse into the atmosphere so readily that, except in enclosed spaces, they may not produce hazardous mixtures in areas close to electrical installations.

Vapors from flammable liquids also have a natural tendency to disperse into the atmosphere, and rapidly become diluted to concentrations below the lower limit of the ignition range, particularly when the air is moving. (Flammable liquids vary in volatility and are defined by the National Fire Protection Assn. as being those liquids having a flash point below 200 F. and a vapor pressure not exceeding 40 psia.)

The vapor densities of various hazardous gases, compared with air, are shown below:

Air	—	1.0
Hydrogen	—	0.069
Acetylene	—	0.90
Ether	—	2.56
Gasoline	—	3.0 – 4.0

Of course, the probability that the gas concentration may be above the upper limit of the explosive range does not afford any degree of safety, as the concentration must first pass through the explosive range to reach the upper limit.

Classification of Hazards

The National Electrical Code, which is widely used for classification purposes, divides explosion hazards into three broad classes, two of which are listed in Table I. The third (Class III) covers flammable fibers and flyings, and is less applicable to the CPI.

Class I atmospheric hazards are divided not only into the four groups shown in the table, but also into two divisions. Division 1 covers locations where flammable gases or vapors may exist under normal operating conditions, under frequent repair or maintenance operations, or where breakdown or faulty operation of process equipment might also cause simultaneous failure of electrical equipment.

Class I, Division 2, covers locations where flammable gases, vapors or volatile liquids are handled either in a closed system, or confined within suitable enclosures, or where hazardous concentrations are normally prevented by positive mechanical ventilation. Areas adjacent to Division 1 locations, into which gases might occasionally flow, would also belong in Division 2.

Class II hazards cover three groups of combustible dusts. Again, this class is separated into two divisions similar to those noted above for Class I.

Copies of the National Electrical Code (NEC) can be obtained from the National Fire Protection Assn., 60 Batterymarch St., Boston.

While Article 500 of the NEC gives more details than we have shown here, considerable skill and judgment is required in deciding to what degree an area contains concentrations likely to be hazardous. Many factors enter into this, including temperature, barometric pressure, humidity, ventilation and distance from the vapor source.

Portable gas analyzers are useful tools in determining the percentage of gas or vapor in the air. However, they have their limitations. Under actual operating conditions, readings may vary from time to time and from place to place within the area being examined, so that an analysis based on only a few readings can be misleading.

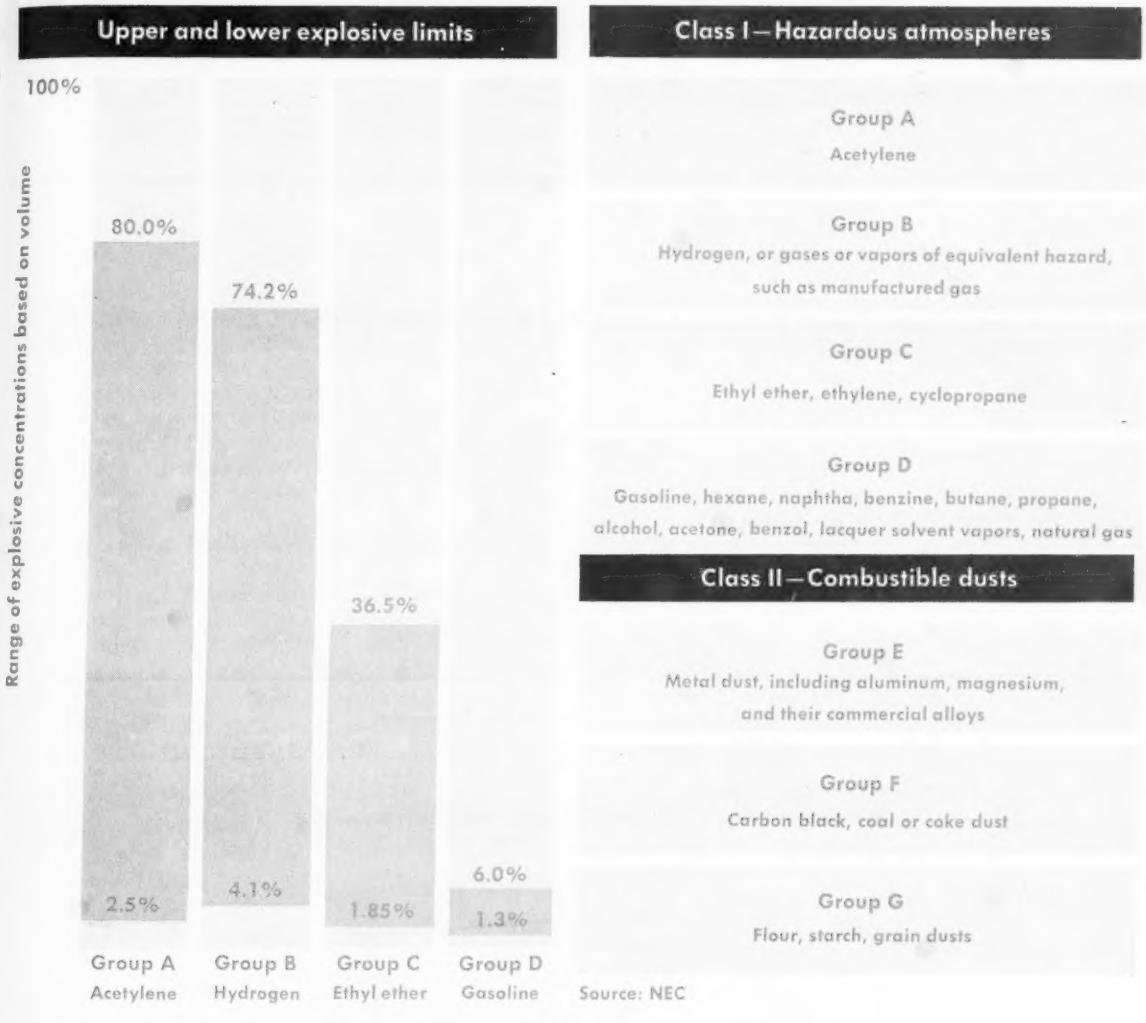
The NEC contains fairly comprehensive information about ether (Class I, Group C) as used in hospital operating rooms, and for gasoline (Class I, Group D) as it may apply to storage areas, garages and gasoline stations. Specific installation practices have been set up for these heavier-than-air vapors. However, there are no such specific data for acetylene, whose vapor density is so near that of air. In the case of hydrogen used indoors, since its vapor density is so low, the most hazardous concentrations are likely to be in the upper portion of the room.

The NEC is considered the definitive classification tool as far as it goes. Insurance companies and their inspectors generally insist that areas in each classification contain only electrical equipment listed and approved for that classification by Underwriters' Laboratories. Most states, municipalities and public service companies also use the NEC as a standard for their inspectors.

API Classification of Areas

For petroleum refineries, the American Petroleum Institute, has prepared API Standard RP 500, titled "API Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries." As outlined in the foreword of the publication, the standard refers to petroleum refineries only, and does not provide a basis for classifying other areas where petroleum or its products are handled. However, it is used widely as a guide in the CPI. Of course, it should not be considered a set of rules or regulations.

Classification of areas where explosion hazards may exist—Table I



Figs. 1, 2 and 3, which are found on the next page, show how areas are classified according to their distance from the source of the hazard. This makes it easier to decide whether an area in a refinery installation should be classified as Division 1, Division 2, or as nonhazardous.

We suggest that anyone desiring to apply these distance factors obtain a copy of API Standard RP 500 from the American Petroleum Institute, Division of Refining, 50 West 50th St., New York 20, N. Y., and study it carefully.

The Chemical Processes Subcommittee of AIEE's Chemical Industry Committee has recently set up a task force to study the possibility of formulating a recommended practice similar to RP 500, but specific to the chemical process industries. This group is headed by J. C. Norton, of Union Carbide, Charleston, W. Va.

Sources of Ignition

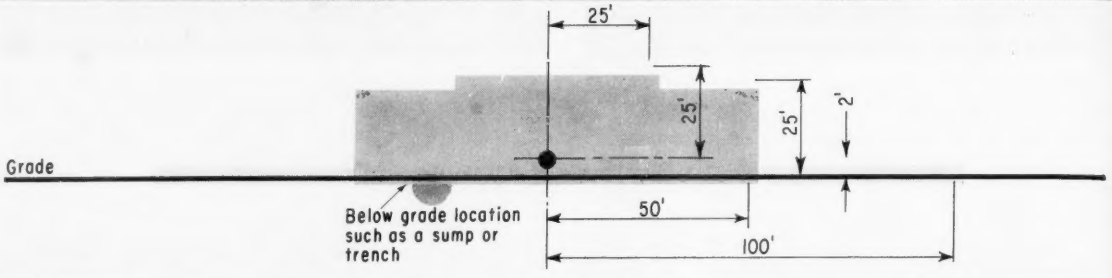
A source of energy is all that is needed to touch off an explosion when flammable gases or combustible dusts are in the proper proportion with air.

One prime source of energy is electricity. Equipment such as switches, circuit breakers, motor starters, pushbutton stations, or plugs and receptacles, can produce arcs or sparks in normal operation when contacts are opened and closed. This could easily cause ignition.

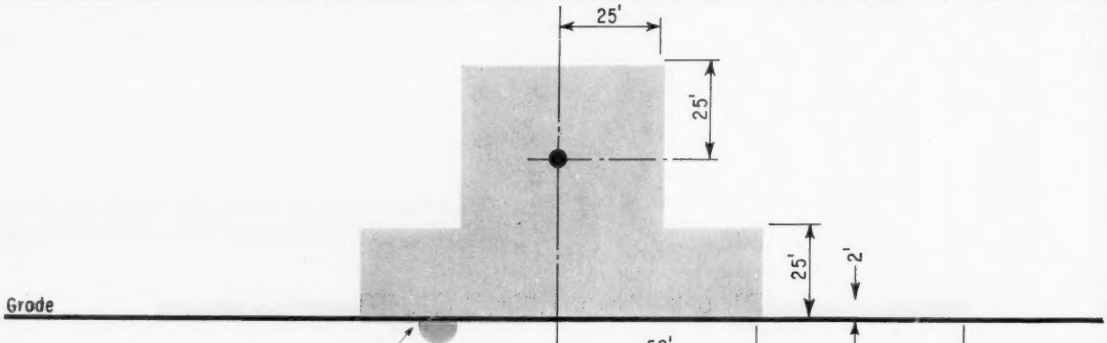
Next in degree of hazard are devices that produce heat, such as lighting fixtures and motors. Here, surface temperatures may exceed the safe limits of many flammable atmospheres. A loose lamp in a fixture socket presents a double hazard, as it may combine arcing with production of the heat.

Finally, many parts of the electrical system can

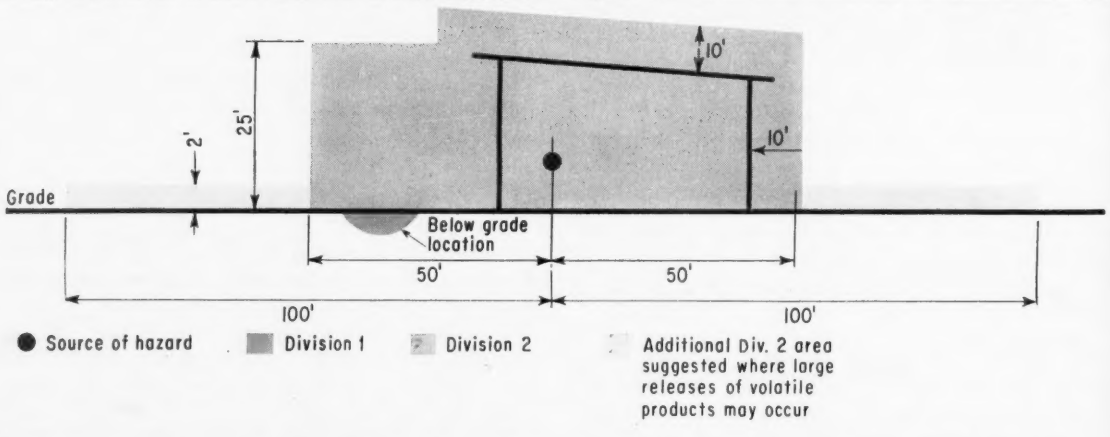
Freely ventilated process area (source of hazard located near grade)—Fig. 1



Freely ventilated process area (source of hazard located above grade)—Fig. 2



Process area with restricted ventilation—Fig. 3



become potential sources of ignition in the event of insulation failure. This group would include wiring (particularly splices in the wiring), transformers, impedance coils, solenoids, and other low-temperature devices without make-or-break contacts.

As for nonelectrical hazards, sparking metal can easily cause ignition. A hammer, file or other tool that is dropped on masonry or on a ferrous surface is thus a hazard, unless the tool is made of nonsparking material. For this reason, portable electric equipment is usually made from aluminum or other material that will not produce sparks if the equipment is dropped.

Open flames (from welding operations, for instance), gas-fired ovens, lightning and static discharge constitute other possible sources of ignition.

Each area in a chemical process plant that is considered hazardous must be carefully evaluated to make certain the correct electrical equipment is selected. The majority of hazardous atmospheres in chemical process plants are Class I, Group D, or Class II, Group G. However, certain areas may involve other groups, particularly Class I, Groups B and C. Conformity with the National Electric Code requires use of fittings and enclosures approved for the specific hazardous mixtures involved. There are only a limited number of electrical items that have been approved for Class I, Groups A and B service. Because of this, Class I, Group D equipment is sometimes used in these atmospheres, but this is not a safe practice. If approved devices are not available, pressurization or isolation by distance should be considered.

Underwriters' Laboratories listing is one of the guiding criteria used in the selection of explosion-proof equipment.

The Work of Underwriters' Laboratories

Underwriters' Laboratories (U/L) is a nonprofit organization sponsored by the National Board of Fire Underwriters. Its function is to determine whether or not devices and materials submitted to it are safe and can be used in the NEC category for which they were designed. To do this, it maintains extensive laboratory and testing facilities.

U/L's function does not include actual enforcement of the National Electric Code. However, as previously indicated, insurance, state and civic inspectors use U/L listing as a criterion in carrying out their inspections of hazardous areas.

U/L listing can take the form of either label service or re-examination service. Under both of these, the prototype of the product is subjected to hydrostatic and other tests by the U/L at its laboratories. The design and construction must be satisfactory for the intended location.

• Under label service, the product is then checked at the supplier's factory by a U/L inspector who checks the electrical construction at frequent intervals to make certain that the U/L requirements are being continuously met. He dispenses the U/L nameplates that eventually go on the product.

This nameplate signifies that the item has been tested, is listed by U/L, and is produced under factory inspection and the label service program.

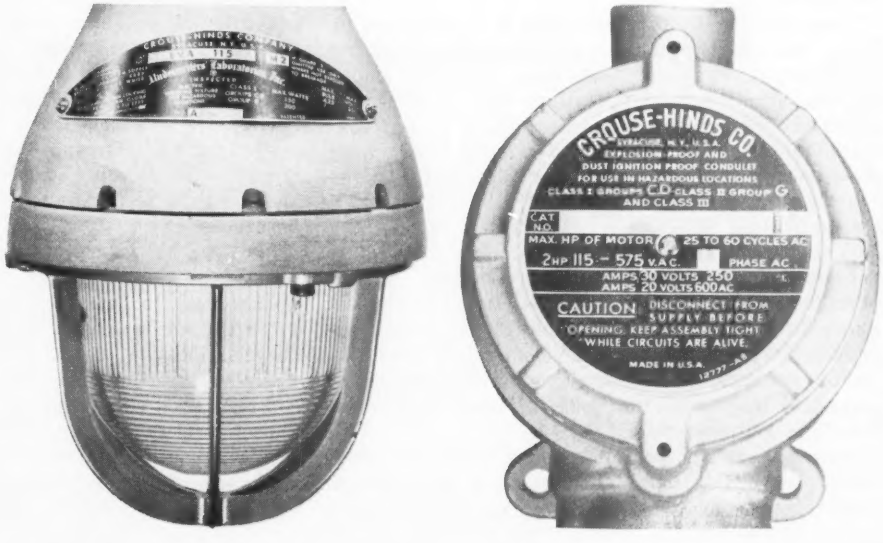
For more complete information on label service, refer to "Hazardous Location Electrical Equipment List" and "Electrical Equipment List," both published by U/L.

• Under Re-examination Service, electrical products are also checked during production by a U/L inspector at the supplier's factory; however, not as frequently. Products covered by this service do not bear the U/L label on the nameplate. However, it is possible to check listing cards of the "Electrical Equipment List" to determine whether or not the item has been tested and listed by U/L.

As many products are available only through the Re-examination Service, lack of the U/L label on the nameplate would not necessarily prejudice an insurance or civic inspector if the product is included in the U/L's current listings.

Use of Nonsparking Devices

In both Divisions 1 and 2 of Class I locations,



Equipment produced under label service bears the U/L label on the nameplace (left). Equipment produced under reexamination service (right) bears only the manufacturer's name.

conventional relays, contactors and switches incorporating metal-to-metal contacts must be enclosed in explosion-proof housings.

This requirement does not apply to solid-state devices, such as magnetic amplifiers or semiconductors, without arcing or sparking contacts.

Static switching devices have no moving parts and thus present fewer mechanical wear and corrosion problems than their conventional counterparts. This results in simplified maintenance.

The power-carrying capacity of these solid-state devices has improved, and may continue to do so. Because of all these factors, use of such devices in the CPI is expected to grow, particularly in Class I, Division 2, locations.

In performing logic or computational functions, the operating power level of some static switching devices may be low enough to make them intrinsically safe even in hazardous locations.

Intrinsically Safe Equipment

To date, very little intrinsically safe equipment is in use. Although the British have done considerable investigation, there does not appear to be sufficient test information or operating experience available in this country at the present time to justify general acceptance of intrinsic safety for Division 1 and 2 applications. However, there is sufficient justification for a thorough study of this field.

Determining the minimum energy that will ignite a hazardous vapor mix is a very complex job. A few of the factors that would affect the value are voltage, type of power, inductance speed to make or break contact, contact materials, the specific type of vapor, and percentage of air-vapor mix.

While many tests have been made both in foreign countries, particularly Great Britain, and in the U. S., we do not know of any U. S. national authority that has accepted fixed minimum current and voltage values for general usage.

Underwriters' Laboratories does list some specific items and parts that are intrinsically safe for hazardous locations. It tests each such item under varying conditions of operation, and attempts to ignite the hazardous vapor, because it is not convinced that current is the only criterion in determining the energy needed to ignite a hazardous mix.

Pressurized Systems

In chemical process plants, pressurized systems permit the safe operation of electrical equipment under conditions of extreme hazard for which approved equipment may not be commercially available.

For instance, most switchgear units and many large-size motors do not come in designs approved for Class I, Groups A and B.

Whether explosion-proof or pressurized enclosures should be used is mainly a question of economics, if both types are available. As a typical example, if an installation had many electronic instruments that could be enclosed in a single sheet-metal enclosure, the installation would lend itself to the pressurization. However, if the instruments, due to their nature, had to be installed in separate enclosures, then the explosion-proof type of housing would almost invariably prove more economical.

Pressurized enclosures require:

- A source of clean air.
- A compressor to maintain the required pressure on the system. (Opinions vary on what this pressure should be. A minimum value accepted by many is 0.1 in. of water.)
- Pressure control valves, to prevent the power from being applied before the cases have been purged, and to de-energize the system should be pressure fall below a safe value.

In addition, door-interlock switches are required, to prevent access to the equipment while the circuits are energized. It can readily be seen that all of these accessories can add up to a considerable expenditure.

The Instrument Society of America has recently prepared a tentative recommended practice booklet, ISA-RP124.4, "Instrument Purging for Reduction of Hazardous Area Classification." Those interested may obtain further information from the Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

The above booklet is one of a series suggesting safe and economical procedures for installing electrical instruments in hazardous atmospheres. It covers one specific phase—a technique for reducing the hazard classification by the continuous addition of an air or inert gas into a general-purpose enclosure. This principle is discussed in the National Electrical Code, Chapter 5, Article 500, Paragraph 500-1:

"In some cases, hazards may be reduced or hazardous areas limited by adequate positive-pressure ventilation from a source of clean air in conjunction with effective safeguards against ventilation failure."

The Instrument Society, in its recommended practice, defines purging as the addition of air or inert gas into an enclosure around the electrical equipment, at sufficient pressure and flow to remove any hazardous vapors, and to prevent their re-entry.

The three purging classifications considered by the Society are as follows:

- Type X Purging—Covers requirements adequate to reduce the classification of the area within an enclosure from Division 1 (hazardous) to nonhazardous.
- Type Y Purging—Covers requirements to change the area within an enclosure from Division 1 (hazardous) to Division 2 (normally nonhazardous).
- Type Z Purging—Covers requirements to reduce the classification of the area from Division 2 (normally nonhazardous) to nonhazardous.

Pressurized enclosures are sometimes also used because the clean dry air inside the case prevents damage and equipment malfunction due to corrosive or damp environmental atmospheres.

Having considered the desirable features of these

housings, we would like to call attention to two disadvantages:

The first is complexity. Because of the almost infinite variety of apparatus that can be enclosed, most installations have to be custom designed.

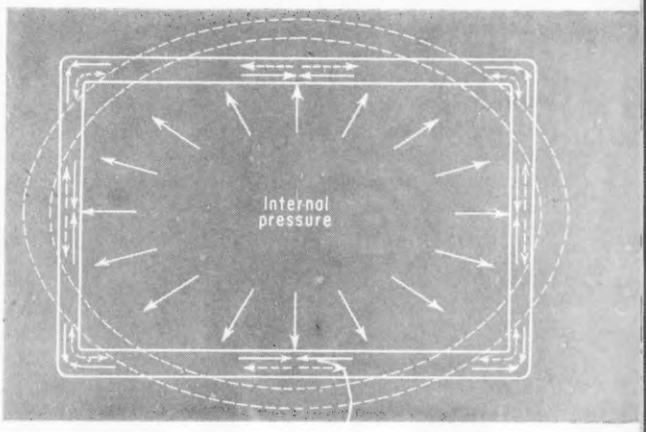
Furthermore, pressurized systems tend to invite abuse. While an explosion-proof enclosure will successfully perform its function unless deliberately modified, pressurized housings by their very nature invite liberties. They seem so open, and the contents are so much like familiar laboratory or electrical apparatus, that rigid field standards are often relaxed. The interlocks have always provoked elaborate and clever schemes for cheating and bypassing.

Explosion-Proof Enclosures

By definition, an explosion-proof enclosure must prevent the ignition of an explosive gas or vapor that may surround it. In other words, an explosion inside the enclosure must be prevented from starting a larger explosion on the outside.

Adequate strength is one requirement for such an enclosure. In most explosion-proof designs, a safety factor of 4 is used, i.e. the item must withstand a hydrostatic test of four times the maximum pressure that could be developed from a hydrocarbon explosion within the enclosure. (It should be pointed out that under short-circuit conditions, pressures may develop that are even higher than those that incorporate this safety factor, and in such cases, even an explosion-proof enclosure may rupture.)

In addition to being strong, the enclosure must be "flame-tight." This term does not imply that the enclosure is hermetically sealed, but rather that the joints or flanges are held within narrow U/L tolerances. These carefully machined joints would cool the hot gases resulting from an internal explosion so that by the time they reached the outside hazardous atmosphere, they would be too cool to effect ignition.



The strains and stresses caused by internal explosive pressure are illustrated in the upper sketch. Dotted line indicates shape that a rectangular enclosure strives to attain under these conditions. Openings in an explosion-proof enclosure can be threaded-joint type (lower right), or of ground-joint type (lower left).

EQUIPMENT FOR HAZARDOUS AREAS

Switchgear and Industrial Controls

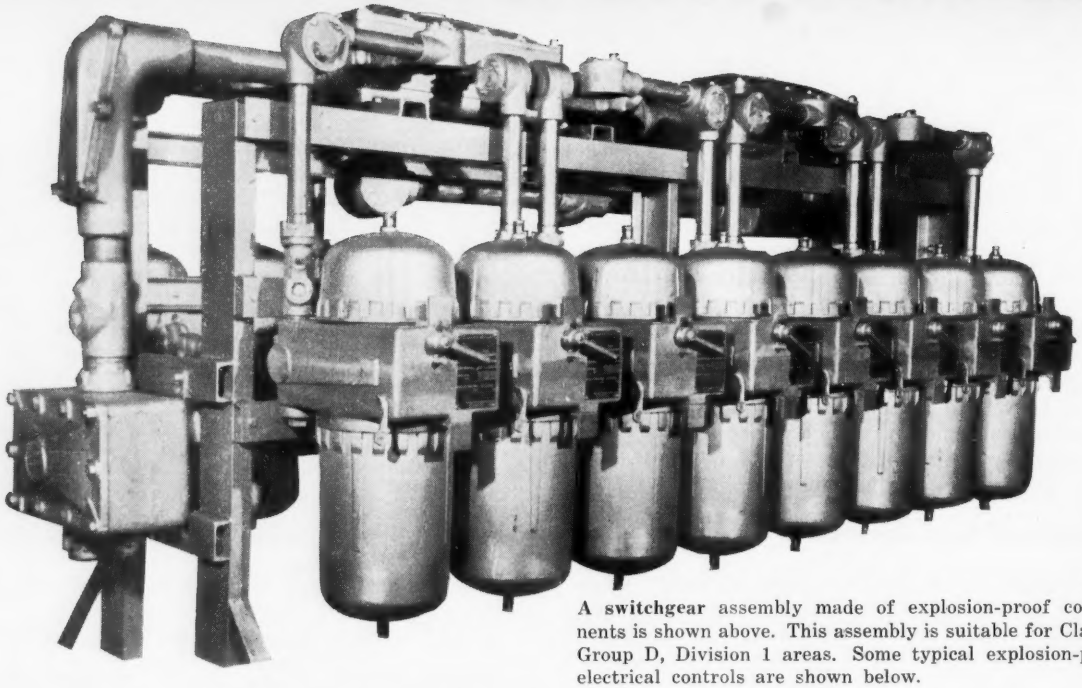
While manufacturers do not list complete switchgear packages suitable for use in hazardous areas, the individual components are readily available in explosion-proof designs. In practice, switchgear installations (main circuit breakers, transformers and primary switches) are often located adjacent to hazardous areas rather than actually in them.

When this is impossible, indoor switchgear in general-purpose enclosures can sometimes be used if the room is purged or ventilated by means of air drawn from a source outside the hazardous area.

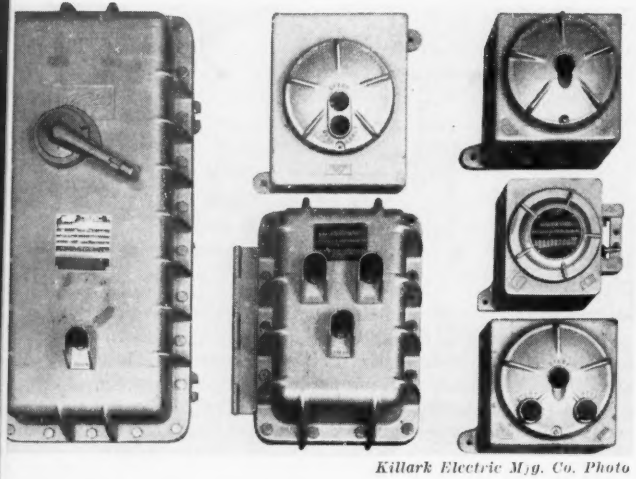
The cost of an assembly using outdoor explosion-proof components must be weighed against the cost and advantages of building an enclosure so that indoor switchgear can be used.

A wide variety of explosion-proof or dust-ignition-proof electrical control equipment is available for Class I and II areas. Explosion-proof pushbutton stations, motor controls and branch circuit breakers are used extensively in these locations. However, as with switchgear, many plants try to install as much as possible of this equipment away from the hazardous areas so that only the remaining control stations have to be explosion-proof.

In industrial control equipment, special oil-immersed apparatus has been listed and approved by Underwriters' Laboratories for Class I, Division 1, areas. This equipment has all arcing parts immersed under 6 in. of oil, and meets other special construction requirements. In Class I, Division 2, areas, standard oil-immersed controls are permitted. In these "chemical type" controls, the oil level is normally two inches



A switchgear assembly made of explosion-proof components is shown above. This assembly is suitable for Class I, Group D, Division 1 areas. Some typical explosion-proof electrical controls are shown below.



Killark Electric Mfg. Co. Photo

above the arcing parts instead of six. These controls are used quite widely, where permitted.

However, the trend of new construction indicates that air-break equipment is gaining increasing favor at the expense of the oil-immersed type, particularly for voltages of 600 or less. Although oil protects parts from direct exposure to corrosive fumes, maintaining the condition and level of the oil can be a problem.

In exposed but nonhazardous areas, industrial controls are usually installed in cast-metal enclosures selected for maximum protection against corrosion and the weather.

Lighting Fixtures

Chemical process plant lighting largely consists of illuminating needed locations without regard to symmetry of installation.

A recent trend has been to classify the majority of lighting areas as Class I, Division 2.

While incandescent lighting is still widely favored in the CPI, many companies are turning to the more efficient mercury vapor fixtures. The wide acceptance of both fluorescent and mercury lighting fixtures has been curtailed to quite a degree by their higher initial cost. However, this is at least partially offset by the lower cost per lumen output, and by the longer lamp life that reduces maintenance.

Standard fluorescent fixtures are generally used for control room lighting, while strategically located floodlights have found wide usage in general lighting, particularly in outdoor areas.

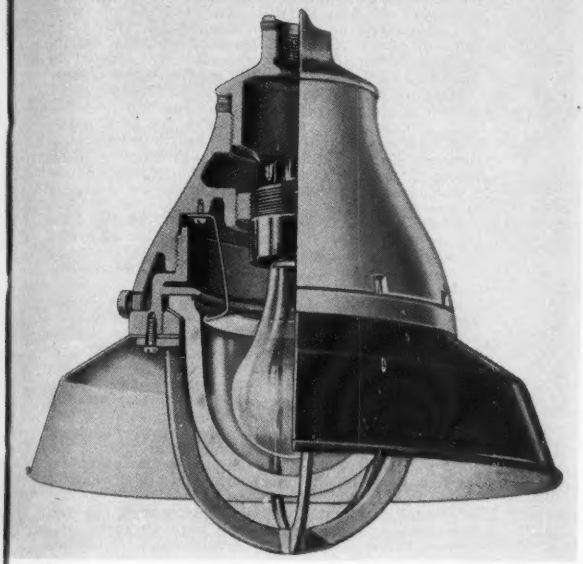
Local lighting is still required in many process and nonprocess areas. If these areas are Class I, Division 1, explosion-proof fixtures are generally used. In Division 2 and nonprocess areas, the fixture generally accepted is the so-called vapor-tight type. Fixtures of this type are now called enclosed and gasketed industrial lighting fixtures to prevent misinterpretation.

In designing any explosion-proof lighting fixture, we are dealing with a heat producing device, and hence operating temperatures become very important.

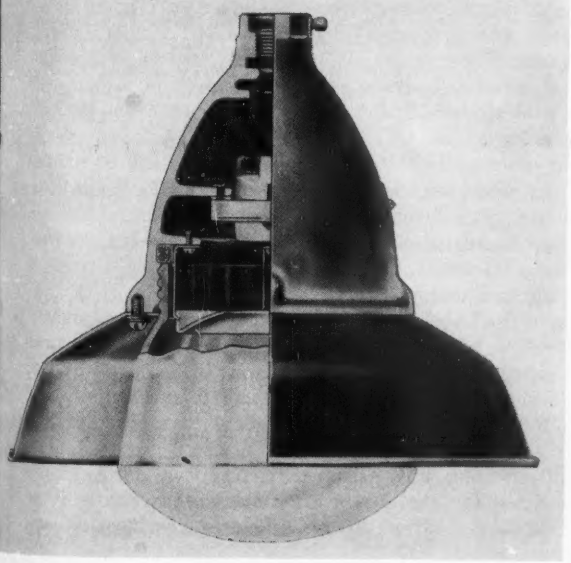
Underwriters' Laboratories has established limiting temperatures for the various groups of gases and vapors listed in Article 500 of the NEC. In designing fixtures for Class I, Division 1, Group C, the external temperature of the enclosure must not exceed 180 C. (356 F.); for Class I, Division 1, Group D, the limit is 280 C. (536 F.). The limits are based on a 40 C. (104 F.) ambient temperature while the device is operating continuously at full rated load, voltage and frequency.

One special U/L design requirement for lighting fixtures in all Class I, Division 1 locations is that the explosion-proof chamber for the lamp must be separated or sealed from the lamp compartment. As a result, no separate seal is required adjacent to U/L-listed lighting fixtures.

Explosion-proof lighting fixture for Class I areas



Dust ignition-proof lighting fixture for Class II areas



When non-explosion-proof fixtures, such as the enclosed and gasketed types, are used in Class I, Division 2 locations, the NEC requires that the operating temperatures of the fixture must not exceed 80% of the ignition temperature of the flammable vapor or dust involved. For example, the ignition temperature of gasoline is 280 C.; therefore, the fixtures' operating temperature in such an environment must not exceed 80% of 280 C., or 224 C. To date, Underwriters' Laboratories does not provide listing service on these Division 2 lighting fixtures. Information on operating temperatures must be obtained from the manufacturer.

To make sure the safe operating temperatures of the fixtures will not be exceeded, maintenance personnel should always be sure to use the proper lamp specified by the manufacturer.

The maximum safe temperatures established by Underwriters' Laboratories for the three Class II dust groups are: Groups E and F—200 C. (392 F.), Group G—165 C. (329 F.). Heat-producing devices used in Class II locations, even when covered by dust deposits, must not attain temperatures higher than the above.

Motors and Generators

As electric motors are needed to drive pumps, compressors, fans, blowers, conveyors and machine tools, their presence in hazardous atmospheres is frequently unavoidable.

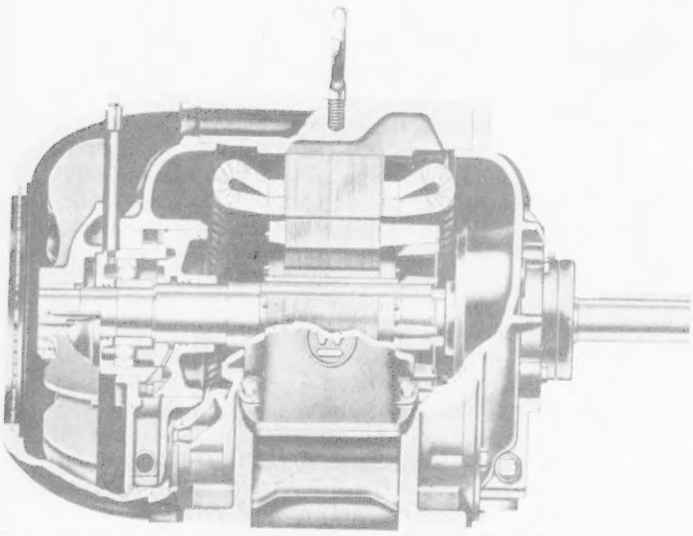
The selection of the proper type of motor is important, since this has a considerable effect on initial cost. The types of hazardous atmospheres and corrosive conditions are both major factors in this selection, as they dictate the degree of protection needed to avoid excessive maintenance and expensive shutdowns.

Corrosive and hazardous conditions vary between areas in the process plants; consequently, no single type of motor construction will suffice for all applications. The types available vary all the way from "drip-proof" to "explosion-proof," which is totally enclosed and fan cooled.

Motors for use in Class I, Division 1, locations should be of the explosion-proof type, suitable for use under the specific conditions encountered in service. Motors for use in Class I, Division 2, locations in which sliding contacts, switching mechanisms or integral resistant devices are employed, must also be explosion-proof.

The National Electrical Code permits the installation of motors without brushes and switching mechanisms (such as squirrel-cage induction motors) in Class I, Division 2, locations in enclosures that are not explosion-proof. Motors of this type are unlikely to fail electrically in the limited time during which the atmosphere surrounding the motor may be hazardous.

Motors for use in a Class I area, either Division 1 or Division 2, should be nonsparking, mechanically as well as electrically. For instance, when a fan-cooled motor is used, the fan should be of a nonsparking material such as aluminum or bronze.



Westinghouse Electric Corp. Photo

This explosion-proof motor is fan-cooled and designed for horizontal mounting. The text of the U/L data service card for electric motors is shown at the right.

E32 Motors, Electric, for Hazardous Locations—Repair and Maintenance

Electric motors for hazardous locations are listed under the Label Service of Underwriters' Laboratories, Inc. Each motor bears a label, which is evidence that it has been produced under the Factory Inspection and Label Service program of the Laboratories.

Repairs of labeled motors after leaving the factory where the motors are produced are not covered by the Factory Inspection and Label Service program of the Laboratories, and the signification of the label, therefore, no longer applies when such repairs have been made. Underwriters' Laboratories is not organized or equipped to supervise repairs of labeled equipment outside of the factories of their manufacture. Where rewinding or other servicing of the motors is required, it is, therefore, recommended that motors be returned to their manufacturers or that such servicing be on the basis of advice from the manufacturers. Local inspection authorities having jurisdiction should be consulted as to the acceptability of repaired motors.

Maintenance of motors for hazardous locations should be conducted by personnel familiar with the unit, function and purpose of the equipment, and with the hazards involved. Some important features of maintenance are discussed below. In all cases, it is essential to adhere to the advices of the manufacturer regarding maintenance or servicing of specific motors.

Electric motors should be disconnected from the supply circuit before disassembling or otherwise opening the motor casings. Seals, where the leads or conductors enter the casings, should not be disturbed.

Machined metal surfaces forming joints and casings of electric motors should be protected from mechanical injury and kept clean. In disassembling or assembling the equipment, hammers or prying tools should not be used in contact with the machined surfaces of joints. Before assembling, old grease, dirt, paint, or other foreign material on surfaces forming joints should be removed. A thin coating of new grease of a type recommended by the manufacturer of the equipment should be applied to joint surfaces. No shims should be placed between surfaces of assembled joints of the motor casing.*

Rewinding a motor will probably disturb the lead wire seal, and may cover the joint surfaces with varnish. Such changes may adversely affect the explosion-proof features of the motor. It is therefore, strongly recommended that motors be rewound by the manufacturers, or in accordance with advice from them.

Rotating shafts should turn freely, but clearances at shaft openings should never be increased to accomplish this. Manufacturer's advice with respect to lubrication and other servicing of bearings should be followed.

Holding bolts and threaded joints of enclosing casings must be kept tight.

* See Card E32—UL116 Explosion-Proof Equipment—Effect of Grease on Joints.

Force-ventilated motors are also used in hazardous locations and are available in any type or size. However, the duct and ventilating system that is required is fairly expensive. Safe air is brought in by this duct system, passes through the motor, and then discharges through another duct system to an area outside of the hazardous location. The ventilating ducts must be pressurized at all times when the motor is running to prevent the entrance of contaminated air into the duct system. This is done by pressurizing fans on the inlet side of the duct system. Auxiliary relays insure an adequate purging of the air system before the motor is started.

Inert gas-filled motors are another possibility for hazardous locations, but their applications are also sometimes limited by cost factors. These motors have tightly fitted covers, and oil seals around the shaft, to minimize gas leakage. The motors are pressurized with an inert gas or safe instrument air and are equipped with an internal air-to-water heat exchanger.

Inert-gas-filled motors are suitable for any hazardous location. In the event of a pressure failure, the wiring system disconnects the motor from its power source, and also triggers a warning alarm. These inert-gas motors would be most applicable in areas classified as Groups A, B and C.

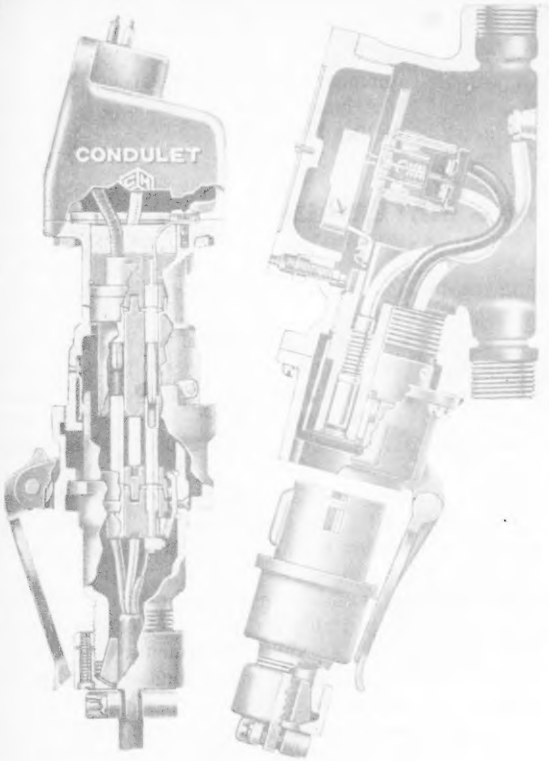
For those interested in U/L design standards for explosion-proof electric motors and generators, the following publications are available from Underwriters' Laboratories, 207 East Ohio St., Chicago 11, Ill.:

• Standard for Electric Motors and Generators for use in Hazardous Locations—Class I, Groups C and D. (This standard is in two parts, the first of which deals with integral horsepower motors, and the second with fractional horsepower.)

• Standard for Electric Motors and Generators for use in Hazardous Locations.

Electric motors for hazardous locations are listed under the Label Service of Underwriters' Laboratories. The U/L label becomes void when the motor enclosure is opened, unless an authorized U/L inspector is present to supervise the work and to reassemble the motor. The data service card above gives further information on U/L Inspection Service.

It should not be assumed that motors and controls designed for one classification are suited for use in a hazardous location of a different classification or group.



Receptacle at the left has a delayed-action interlocking sleeve. Contact can only be made after the sleeve is tightened, thereby confining arcs to the explosion-proof chamber. Receptacle at the right is constructed with an interlocked switch. Rotating the plug after insertion actuates this switch.

Plugs and Receptacles

In the majority of explosion-proof devices, all of the current-carrying parts are inside the enclosure. However, in plugs and receptacles, some of the current-carrying parts must protrude through the walls of the enclosure so that electrical contact can be made. The problem is to make such a device safe for use in explosive atmospheres.

Two different methods can be used:

1. *Interlocked*—The receptacle contacts are interlocked with a switch located in an explosion-proof enclosure, so that the receptacle contacts will always be dead when the plug is inserted or withdrawn.

2. *Delayed Action*—The plug and receptacle are so constructed that any electrical arcs that may occur at the contacts will be confined inside explosion-proof chambers. This design also prevents the rapid withdrawal of the plug from the receptacle, thereby giving any heated metal parts or particles some time to cool before they come in contact with the surrounding explosive atmosphere.

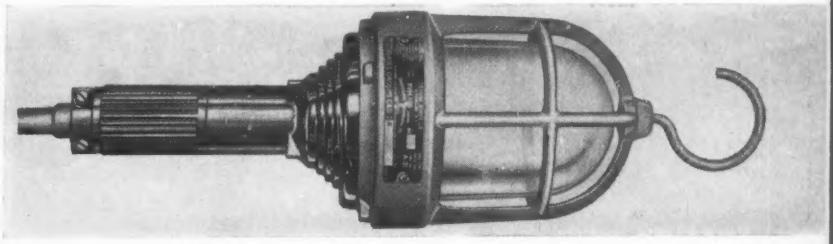
Both designs are practical and widely used.

Portable Devices

The design of portable units for use in hazardous locations must permit ready replacement of Type S or SO (oil resistant) flexible cord when the cord becomes impaired. Hence, it is usual to have a separate compartment or connector for the cord connections outside of the explosion-proof compartment. This wiring compartment or connector need not be explosion-proof.

In many chemical plants, portable equipment is

Appleton Electric Co. Photo



This explosion-proof extension reel is suitable for automatic take-up of electric cable in hazardous areas. Below it is an explosion-proof hand lamp. Guard and globe holder are of cast aluminum.

restricted as much as possible. When it is used, explosion-proof construction is specified.

The National Electrical Code (250-45) requires that all portable equipment operated in hazardous locations at less than 150 v. be grounded by means of a separate conductor in the flexible cord.

WIRING METHODS AND MATERIALS

Conduit and Fittings

In Class I, Division 1, locations, all conduit must be of rigid metal, with at least five full threads engaged in the explosion-proof enclosure. For Division 2 locations, the use of rigid conduit is also the generally accepted practice.

The most common method of wiring in the chemical process industries employs thick-walled conduit with a sherardized finish. Despite protective finishes on conduit, various types of paints are used extensively by maintenance groups to give additional corrosive protection.

Aluminum conduit and fittings of conventional and low copper content are being evaluated for future use by many companies. The American Standards Assn. (C 80.5-1960) permits aluminum conduit with maximum of 0.4% copper.

There is a prime need for standardization of copper content in aluminum fittings. It is generally accepted by most authorities in the field that low-copper-content aluminum fittings should not have a copper content of more than 0.4%. At this point or below, the corrosion attack on aluminum alloys in most atmospheres found in the CPI is not likely to cause serious trouble.

Mineral-Insulated Cable

Another type of wiring system that is gaining in usage is mineral-insulated (MI) cable. Mineral-insulated wiring consists of copper conductors properly spaced and encased in tightly compressed magnesium oxide, clad in an over-all copper sheath that is completely flexible.

Below the melting temperature of the copper sheath, MI cable is impervious to fire. Actually, because of limitations on end connections, its operating range is generally considered to be −40 to 80 C. with standard terminals, and up to 250 C. with special terminals.

When properly installed, MI cable is suitable and approved for all Class I and Class II locations. Approved termination fittings are available for Class I, Group C and D, areas.

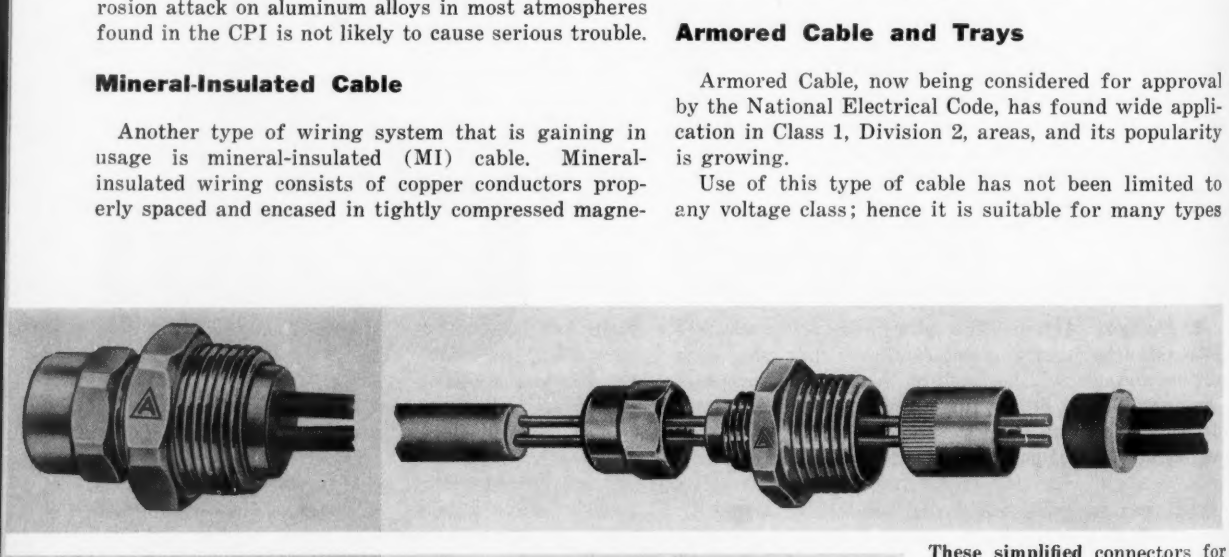
MI cable is available in one to seven conductors, making it most suitable for wiring of control boards, control components and instrumentation circuits where crowded conditions make conduit installations difficult and expensive.

Inasmuch as MI cable is hygroscopic, moisture can be a problem, particularly when the ends are left exposed. Care must be taken to install and seal the end fittings on the job as soon as possible to prevent moisture accumulation. If moisture enters, the end must be cut off or dried out with a torch.

Armored Cable and Trays

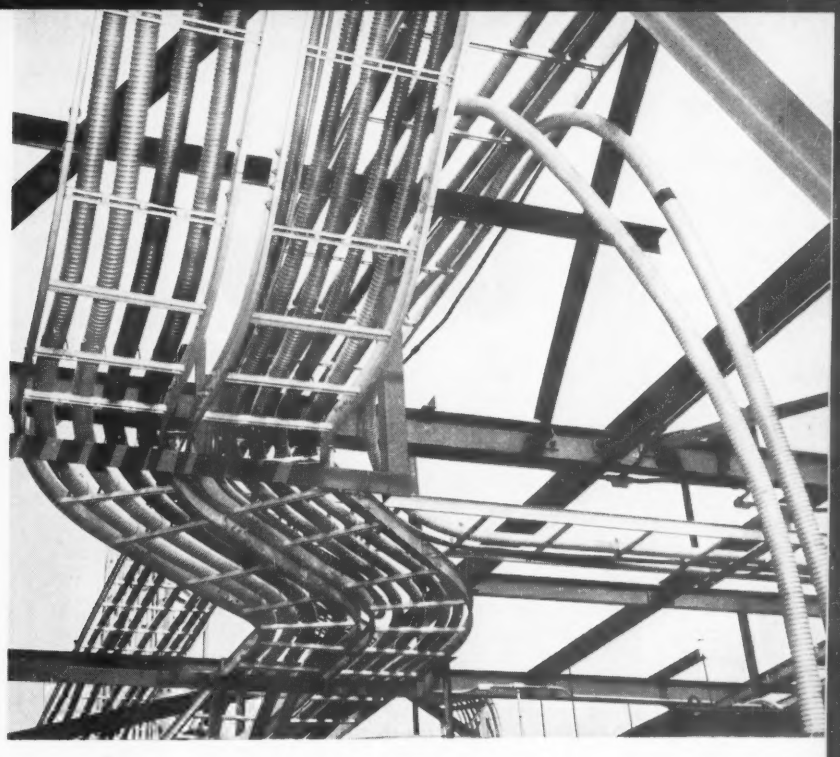
Armored Cable, now being considered for approval by the National Electrical Code, has found wide application in Class 1, Division 2, areas, and its popularity is growing.

Use of this type of cable has not been limited to any voltage class; hence it is suitable for many types



These simplified connectors for the installation of MI cable come in two styles—the one above is for threaded conduit hubs, the one below for steel-junction-box knockouts.

Appleton Electric Co. Photo



Armored cable supported by cable trays offers cost-saving possibilities. NEC approval is expected.

U. S. Steel Corp. Photo

of installations. The armor itself is available in various metals such as galvanized steel, aluminum, bronze and stainless steel. When further protection from chemical attack is needed, jackets of rubber, neoprene or varnished cambric can be applied over the armor. The most popular jacketing material is a plastic sheath, usually of polyvinyl chloride.

Low cost, flexibility and other advantages have stimulated the use of interlocked armored cables.

Armored cable must be properly terminated. A sealing fitting is needed where the cable enters an explosion-proof housing. Since the armor must not be used as a grounding or neutral conductor, there should be a separate conductor in the cable for this.

When armored cable is run above ground, it is generally supported by a cable tray. Many chemical companies report that the use of cable trays has substantially reduced the cost of control and power wiring.

With larger control rooms, if one considers the space requirements and costs for a 100% conduit system, to say nothing of the many problems that arise when an additional cable has to be installed, the cable tray system offers attractive possibilities for economy. In many plants, however, cable tray systems have been kept at a minimum because of corrosion and maintenance problems.

Plastic Conduit

Some types of plastic rigid conduit have been approved by Underwriters' Laboratories for direct underground burial or encasing in concrete. If in the future the National Electrical Code approved this conduit for above-ground installations, many more CPI plants would use it, thereby eliminating the metal raceway corrosion that takes place in certain chemical atmospheres.

Plastic conduit is a nonconductor and cannot be used as an equipment ground. Accordingly, a grounding wire must be run through the plastic raceway in practically all industrial applications.

In addition to corrosion resistance, some of the advantages of plastic conduit are its light weight and its nonmagnetic and nonsparking properties. However, plastic conduit has a high coefficient of expansion, and adequate allowances must be made for this, particularly in outdoor installations. Furthermore, more conduit supports are needed than for conventional conduit.

To date, many CPI engineers prefer the cement-type joint for connecting plastic conduit with fittings, rather than the threaded type.

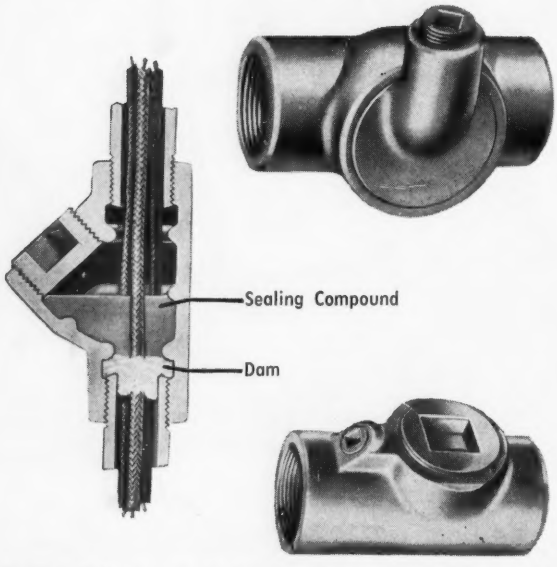
Seals for Conduit Systems

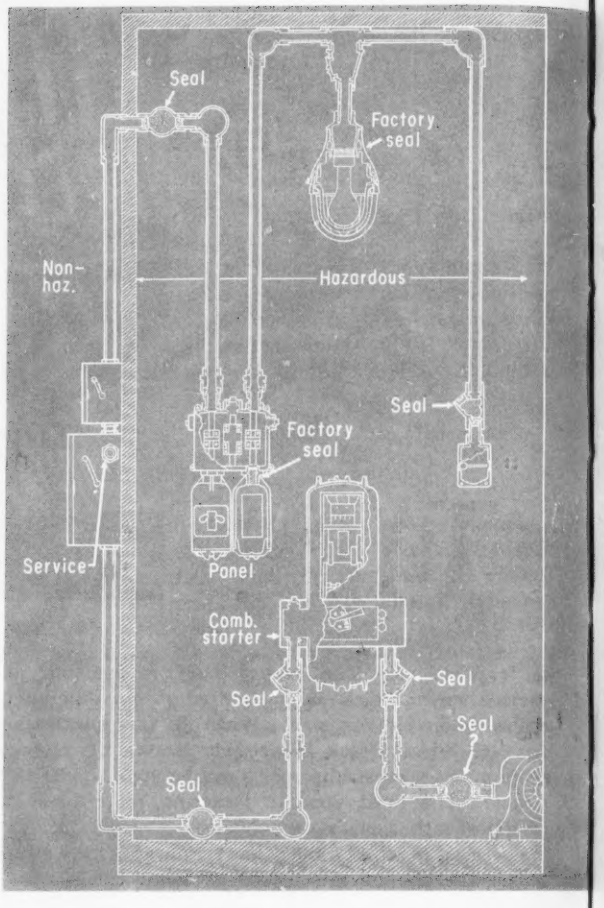
Seals prevent the passage of gases, vapors or flames from one section of rigid conduit system to another, thus limiting an explosion to a single explosion-proof enclosure. Seals also stop precompression or "pressure piling"—the build-up of terrific pressures in the conduit system caused by successive explosions.

A seal consists of a fitting containing a fast-setting compound that is not attacked by gases or heat. Only the compound specified by the fitting manufacturer should be used.

In hazardous locations, seals are needed in the following instances:

- Where the conduit enters an explosion-proof enclosure that houses arcing or high-temperature equipment. (A seal must be within 18 in. of the explosion-proof enclosure it isolates.)





Sealing fittings must be incorporated in the wiring so that explosions are limited to one enclosure. The seal adjacent to the motor in the lower-right-hand corner is needed only if the conduit is more than 2 in. wide.

• Where the conduit enters enclosures that house terminal splices or tapes, if the conduit is 2 in. or more in diameter.

• Where the conduit leaves a Division 1 area or passes from a Division 2 hazardous area to a nonhazardous location.

A question that frequently arises in a hazardous location installation is whether the National Electrical Code permits union fittings between the seal and arcing device.

Paragraph 501-5 (a) 1 of the 1959 National Electrical Code, which deals with the requirements of seals within 18 in. of the arcing device, places no restrictions on the use of unions adjacent to the enclosure. Since the fittings are U/L listed without restriction and are tested for the worst conditions of flame propagation and pressures, there is no need to avoid unions between the seal and the arcing device.

Obviously, union fittings should be installed properly, no matter what the location. The conduit lines should be aligned carefully so that the explosion-proof joints are not held open.

Alternate changes in temperature and barometric pressure cause "breathing"—the entry and circulation of air throughout the conduit. As joints in a conduit system and its components are seldom tight enough to prevent this breathing, moisture in the air condenses at the base of vertical conduit runs and equipment enclosures. This could cause equipment shorts or grounds. To eliminate this condition, inspection fittings equipped with explosion-proof drains that automatically bleed off the water should be installed.

MAINTENANCE PRINCIPLES

Articles 500-503 of the NEC require equipment to be constructed and installed in such a way as to insure safe performance under conditions of proper use and maintenance. Therefore, it is assumed that users will exercise special care in installation and maintenance.

Proper maintenance of electrical equipment in hazardous locations is specified (but not spelled out) in NEC Article 500, paragraph 500-2, Special Precaution.

In addition, it is important that the following points be checked carefully:

Electrical Circuits—Electrical equipment should be serviced or disassembled only after first de-energizing the electrical supply circuits. This also applies when lighting fixtures or units are partially disassembled

for relamping. All electrical enclosures should be tightly reassembled before the supply circuits are again re-energized.

Assembly or Disassembly of Enclosures—Hammers or prying tools must not be allowed to damage the flat ground-joint surfaces. Do not handle covers roughly, or place them on surfaces that might damage or scratch the flat ground-joint surfaces. Protect all surfaces that form a part of the flame path from mechanical injury. In storing equipment, always make sure that covers are assembled to their mating bodies.

Cover Attachment Screws—All cover screws and bolts intended to hold explosion-proof joints firmly together must always be tight while circuits are alive. Leaving one screw or bolt loose, may render the equipment unsafe. Care should be taken to use only bolts or screws provided by the equipment manufacturer, as the substitution of other types of material may weaken the assembly and render it unsafe.

Cleaning and Lubrication—Particles or foreign material should not be allowed to accumulate on flat ground-face joints, as these materials tend to prevent a close fit and may permit dangerous arcs, sparks or flames to propagate through them.

When assembling, remove all old grease, dirt, paint or other foreign material from the surfaces, using a brush and kerosene or a similar solvent with a flash point higher than 38 C. (100 F.). A film of light oil or lubricant of a type recommended by the original equipment manufacturer should be applied to both body and cover joint.

Any lubricated joints exposed for long periods of time may attract small particles of dirt or other foreign material. To avoid this, body and cover joints should be re-assembled immediately.

Threaded joints should be tightened sufficiently to prevent accidental loosening due to vibration, but they should not be forced. If the threads are kept clean and lubricated, safe operation can be assured with a minimum of maintenance.

Shaft and Bearing Surfaces—Because a rotating shaft must turn freely, the clearance between shaft and bearing are carefully established within close tolerances by the equipment manufacturer. This clearance should never be increased because this would provide a path for flames or sparks to escape to the outside hazardous atmosphere. Always follow the manufacturer's recommendations with respect to lubrication and other servicing of shafts and bearings.

Corrosive Locations—Threaded covers, flat joints, surfaces, rotating shafts, bearings and operating shafts should be well lubricated. If corrosion products have accumulated on explosion-proof joints or surfaces and cannot readily be removed with solvents, the parts should be discarded and replaced. Never use an abrasive material or a file to remove the corrosion products from threaded or flat-joint surfaces. In extremely corrosive locations, equipment should be periodically inspected to guard against unusual deterioration and possible porosity, since this may weaken the enclosure structurally.

Portable Equipment—The extra-hard-usage rubber-covered flexible cord that should be used with this equipment must be examined frequently and replaced

Explosion-proof equipment needs particularly careful maintenance. This technician is draining the grease purger on an induction-type, explosion-proof motor.

General Electric Co. Photo

at the first indication of mechanical damage or deterioration. Terminal connections to the cord must be properly maintained. In general, where portable equipment is necessary, avoid rough handling and inspect the assembly frequently.

Over-all Safety—Safety in hazardous locations may be endangered if additional openings or other alterations are made in explosion-proof assemblies.

In painting the exterior of explosion-proof housings, care should be taken not to obscure the nameplate, which may contain cautionary or other information of importance to maintenance personnel.

Plug-In Replacement Units—One technique that speeds and eases the work of the maintenance department is the use of plug-in type electrical equipment that allows the substitution of a replacement unit while the original unit is being repaired outside the hazardous area.

NEED FOR NEW PROCEDURES AND PRODUCTS

Additional Standards Would Help

Interviews conducted by the author among the chief electrical engineers, safety engineers and plant maintenance engineers of many CPI plants brought out that the following additional procedures and standards would be very helpful:

1. Specifications should be developed equivalent to the American Petroleum Institute's RP-500, but tailored to the needs of the CPI. These should include distance and gas concentration data to help in the classification of areas. It would also be very helpful if these specifications would set up standards for the design and selection of equipment (especially lighting fixtures) for Class I, Division 2, locations. This division has been growing in importance in the CPI. Well-defined standards for equipment would provide a basis for more consistent practices throughout the CPI.

2. It would be a big help to equipment purchasers and inspectors if some central agency could serve as a clearing point for classifying the many chemicals that are not dealt with in the NEC.

Need for New Products

1. There is a definite trend toward the classification of hazardous areas as Class I, Division 2, rather than Class I, Division 1. As a result, it is felt that suppliers should enlarge their lines of Class I, Division 2, equipment. In many instances, the user has no alternative but to purchase equipment designed for use in Division 1 locations. Developments in the areas of contactless devices, hermetic sealing and intrinsically safe devices should promote the design of electrical equipment exclusively for Division 2 locations.

2. A greater variety of explosion-proof instrument enclosures should be made available for Class I, Division 1, and Class I, Division 2, areas. Whereas purging and pressurization are now used in many areas for instruments, the lower cost of an explosion-proof enclosure, if available in the proper size and not too heavy, makes it a logical type of installation.

3. A majority of engineers feel that suppliers should offer a more complete line of pressurization-type enclosures for instruments and electrical apparatus that cannot readily be enclosed in an explosion-proof housing. These enclosures should be a complete package, including interlocks, gages and other accessories.

4. While MI cable has grown in use in many hazardous areas, sealing the end fittings can be somewhat ticklish due to rapid pick-up of moisture by the magnesium oxide insulation. Some engineers feel that the design of the end fittings could be further improved.

5. Improved lighting would be helpful for instruments and panelboards in Class I, Division 2, control rooms. Due to increasingly complex processes, more and more equipment is being placed on the control panelboard. As a result, manufacturers are making the instruments smaller. Facilities for local lighting within the instrument enclosure would therefore make proper viewing of these instruments easier.

Meet the Author

RICHARD W. SCOTT *joined the Crouse-Hinds Co. immediately after obtaining his B.S. in electrical engineering at Syracuse University in 1936.*

After various tours of duty in the engineering, technical sales and administrative field, he assumed his present position of administrative engineer, with responsibility for the coordination of the company's product research and development program.

He is national chairman of the chemical industry committee of the AIEE.

How to Figure Transfer Units From Theoretical Plates

Column design may involve both transfer units and theoretical plates. Here's how to relate them for equimolal diffusion.

A. J. SUROWIEC, *Maplewood, N. J.*

It is sometimes desirable to convert theoretical plates into transfer units in a design problem. To do so, with an error less than 4% when equilibrium curve and operating line are not straight lines, the following method is proposed.

Consider a section of a distillation tower with neither feed nor product sidestreams. The composition changes across such a tower section can be expressed conveniently in terms of a telescoping series:

$$(y_1 - y_{n+1}) = \sum_{k=1}^{n} (y_k - y_{k+1}) \qquad (1a)$$

$$(x_0 - x_n) = \sum_{k=1}^{n} (x_{k-1} - x_k) \qquad (1b)$$

Rearranging Eqs. (1),

$$(y_1 - y_{n+1}) = -\tfrac{1}{2}(y_0 - y_1) + \sum_{k=1}^{n} \tfrac{1}{2}[(y_{k-1} - y_k) + (y_k - y_{k+1})] + \tfrac{1}{2}(y_n - y_{n+1}) \qquad (2a)$$

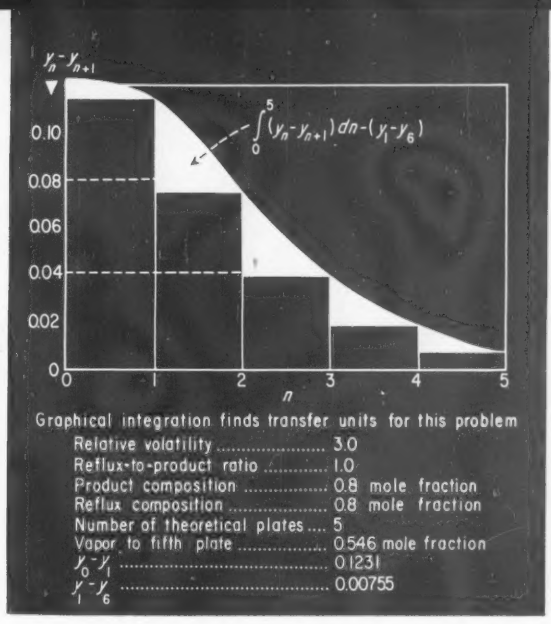
$$(x_0 - x_n) = \tfrac{1}{2}(x_0 - x_1) + \sum_{k=1}^{n} \tfrac{1}{2}[(x_{k-1} - x_k) + (x_k - x_{k+1})] - \tfrac{1}{2}(x_n - x_{n+1}) \qquad (2b)$$

A Graphical Approximation

The sum of terms in Eqs. (2) is the trapezoidal approximation for the area beneath a curve. Eq. (2) can be rewritten in integral form as

$$(y_1 - y_{n+1}) = \int_0^n (y_n - y_{n+1})\, dn + \tfrac{1}{2}\int_0^n d(y_n - y_{n+1}) \qquad (3a)$$

$$(x_0 - x_n) = \int_0^n (x_n - x_{n+1})\, dn - \tfrac{1}{2}\int_0^n d(x_n - x_{n+1}) \qquad (3b)$$



Graphical integration finds transfer units for this problem

Relative volatility	3.0
Reflux-to-product ratio	1.0
Product composition	0.8 mole fraction
Reflux composition	0.8 mole fraction
Number of theoretical plates	5
Vapor to fifth plate	0.546 mole fraction
$y_0 - y_1$	0.1231
$y_1 - y_6$	0.00755

And differentiation of Eqs. (3) gives

$$dn = [-dy_{n+1}/(y_n - y_{n+1})] - \tfrac{1}{2}d\ln(y_n - y_{n+1}) \qquad (4a)$$

$$dn = [-dx_n/(x_n - x_{n+1})] + \tfrac{1}{2}d\ln(x_n - x_{n+1}) \qquad (4b)$$

If the finite difference and its differential are expanded in terms of a Taylor series, you will see that a second-order approximation has been made—only third- and higher-order terms have been neglected.

Introduce a Correction Factor

The integration of Eqs. (4) is facilitated by the following identities:

$$d(y_n - y_{n+1})/dy_{n+1} = [(dy_n/dx_n)/(dy_{n+1}/dx_n)] - 1 \qquad (5a)$$

$$d(x_n - x_{n+1})/dx_n = 1 - [(dy_{n+1}/dx_n)/(dy_{n+1}/dx_{n+1})] \qquad (5b)$$

Derivatives in the above relationships are the slopes of the equilibrium curve and the operating line.

To test the accuracy of Eq. (4), the integration can be carried out when the relationship between operating line and equilibrium curve is known. For this purpose, the ratio of the composition changes across adjacent trays is given by:

$$r_{y,\,n} = (y_n - y_{n+1})/(y_{n-1} - y_n) \qquad (6a)$$

$$r_{x,\,n} = (x_n - x_{n+1})/(x_{n-1} - x_n) \qquad (6b)$$

When the composition change across a theoretical plate is linear in the mainstream composition, the ratio of the changes of composition across adjacent trays is also constant, and

$$r_y = \frac{\Delta y_{n+1}}{\Delta y_n} = \frac{(dy_{n+1}/dx_n)}{(dy_n/dx_n)} \qquad (7a)$$

$$r_x = \frac{\Delta x_{n+1}}{\Delta x_n} = \frac{(dy_{n+1}/dx_n)}{(dy_{n+1}/dx_{n+1})} \qquad (7b)$$

Note that if Eqs. (7a) and (7b) are simultaneously satisfied, $r_x = r_y$, and the equilibrium curve and the operating line are straight.

When either Eq. (7a) or (7b) holds, then integration of Eq. (4) for a single theoretical tray yields

$$C_y = \frac{\frac{1}{2}(r_y + 1)\ln r_y}{(r_y - 1)};\ r_y \text{ constant} \quad (8a)$$

$$C_x = \frac{\frac{1}{2}(r_x + 1)\ln r_x}{(r_x - 1)};\ r_x \text{ constant} \quad (8b)$$

The quantity C in Eq. (8) gives the ratio of the calculated number of trays to the actual number. Since C is the ratio of the arithmetic average to the logarithmic average of the composition changes across adjacent trays, it will have a value less than 1.04 when r lies between 0.5 and 2.

The ratio of arithmetic and logarithmic averages represented by Eq. (8) can be satisfactorily approximated by[1]

$$C_n = 1 + (\ln r_n)^2/12 \quad (9)$$

When r is not constant, two values of quantity C can be calculated at a point on the operating line. To avoid an overcorrection for the approximate nature of Eq. (4), a correction factor can be defined by

$$C^{(n)} = \min\,(C_n, C_{n+1}) \quad (10)$$

Eq. (4) is then modified to give

$$C_y^{(n)}\,dn = \frac{-dy_{n+1}}{(y_n - y_{n+1})} - \tfrac{1}{2}d\ln\,(y_n - y_{n+1}) \quad (11a)$$

$$C_x^{(n)}\,dn = \frac{-dx_n}{(x_n - x_{n+1})} + \tfrac{1}{2}d\ln\,(x_n - x_{n+1}) \quad (11b)$$

Integrate to Calculate

Eq. (11) is conveniently integrated with the aid of the following defining equations for the number of transfer units and the height of a transfer unit:[2]

$$N_{OG} = -\int_0^n dy_{n+1}/(y_n - y_{n+1}) \quad (12a)$$

$$N_{OL} = -\int_0^n dx_n/(x_n - x_{n+1}) \quad (12b)$$

$$\frac{\text{HETP}}{\text{HTU}_{OG}} = N_{OG}/n \quad (13a)$$

$$\frac{\text{HETP}}{\text{HTU}_{OL}} = N_{OL}/n \quad (13b)$$

An average value of $C^{(n)}$ can be arrived at from an average value for r in the following manner:

$$-n\ln r_{y,\,av} = \ln\left(\frac{y_0 - y_1}{y_n - y_{n+1}}\right) \quad (14a)$$

$$-n\ln r_{x,\,av} = \ln\left(\frac{x_0 - x_1}{x_n - x_{n+1}}\right) \quad (14b)$$

With the help of Eqs. (9), (12), (13) and (14), an integrated form of Eq. (11) is given as

$$\frac{\text{HETP}}{\text{HTU}_{OG}} = \frac{N_{OG}}{n} = 1 + \frac{1}{12}\left[\frac{\ln\left(\frac{y_0 - y_1}{y_n - y_{n+1}}\right)}{n}\right]^2 - \tfrac{1}{2}\left[\frac{\ln\left(\frac{y_0 - y_1}{y_n - y_{n+1}}\right)}{n}\right] \quad (15a)$$

$$\frac{\text{HETP}}{\text{HTU}_{OL}} = \frac{N_{OL}}{n} = 1 + \frac{1}{12}\left[\frac{\ln\left(\frac{x_0 - x_1}{x_n - x_{n+1}}\right)}{n}\right]^2 + \tfrac{1}{2}\left[\frac{\ln\left(\frac{x_0 - x_1}{x_n - x_{n+1}}\right)}{n}\right] \quad (15b)$$

When either $r_{y,\,n}$ or $r_{x,\,n}$ is constant, then the following *exact* relations are obtained:

$$\frac{\text{HETP}}{\text{HTU}_{OG}} = \frac{N_{OG}}{n} = \frac{r_y \ln r_y}{(r_y - 1)};\ r_y \text{ constant} \quad (16a)$$

$$\frac{\text{HETP}}{\text{HTU}_{OL}} = \frac{N_{OL}}{n} = \frac{\ln r_x}{(r_x - 1)};\ r_x \text{ constant} \quad (16b)$$

Values of r in the above relations are obtained from Eq. (14). The integrals for the number of transfer units can be evaluated by

$$N_{OG} = -\frac{\Delta\, y_{n+1}}{\Delta\,(y_n - y_{n+1})}\,\Delta\ln\,(y_n - y_{n+1});\ r_y \text{ constant} \quad (17a)$$

$$N_{OL} = -\frac{\Delta\, x_n}{\Delta\,(x_n - x_{n+1})}\,\Delta\ln\,(x_n - x_{n+1});\ r_x \text{ constant} \quad (17b)$$

Try a Numerical Example

As a numerical example in the use of the above equations, consider the binary separation problem that is shown in the table on the previous page. From Eq. (15a):

$$\frac{N_{OG}}{n} = 1 + \frac{1}{12}\left[\frac{2.3\log_{10}(0.1231/0.00755)}{5}\right]^2 - \tfrac{1}{2}\left[\frac{2.3\log_{10}(0.1231/0.00755)}{5}\right]$$

$$= 0.7468$$

$$N_{OG} = 5\,(0.7468) = 3.73$$

N_{OG}, (graphical integration) = 3.70

In multicomponent systems, components of interest frequently go through maximum concentrations, while the ratios of concentrations rarely do so in well-designed systems. A parallel development is possible for multicomponent systems by replacing y_{n+1} by $\ln\,(y_i/y_j)_{n+1}$ where $y_{i,\,n+1}$ and $y_{j,\,n+1}$ are the components of interest.[3]

Nomenclature

C	Correction factor in Eq. (8).
ln	Napierian logarithm.
n	Theoretical plate number, counting from top.
N_{OG}	Number of transfer units in over-all gas concentrations.
N_{OL}	Number of transfer units in over-all liquid concentrations.
x_n	Mole fraction in the liquid leaving plate n.
y_n	Mole fraction in the vapor leaving plate n.

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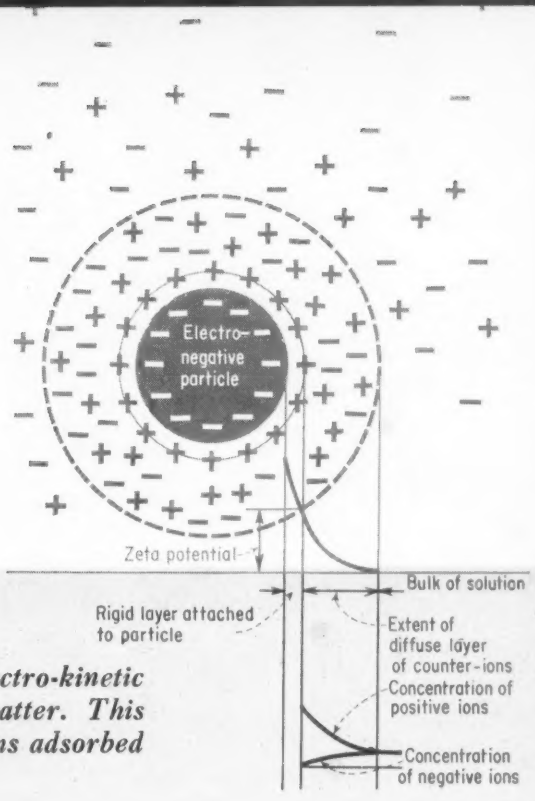
Zeta-Potential: New Tool for Water Treatment Part II



The zeta potential is a measure of the electro-kinetic charge surrounding suspended particulate matter. This charge is caused by an excess of negative ions adsorbed at the surface of the particle, as shown.

THOMAS M. RIDDICK
Consulting Engineer and Chemist

The fundamental principle of electro-osmosis (the forerunner and in many respects the inverse of electrophoresis) was discovered about 150 years ago.

In early experiments, it was noted that if a ball of clay was submerged in water, and two glass tubes were inserted in the clay with their ends projecting above the water, then a d.c. voltage connected to electrodes in the tubes would cause the liquid to be elevated above the water surface in one tube, and depressed in the other. A reversal in polarity would reverse the order of liquid elevation or depression. Thus, an immovable solid (the packed clay) causes a movement of the liquid—this is electro-osmosis.

In electrophoresis, a suspended solid (such as discrete particles of colloidal clay) moves in a d.c. field in relation to the suspending liquid (water).

The basic meaning of zeta potential is set forth quite simply above. The pictured colloidal particle is, as are practically all raw-water colloids and proteins, electro-negative, since it has adsorbed an excess of negative ions at its outer surface. The preferential adsorption (or existence) of negative ions at the surface of most colloids has been the subject of much investigation. An oversimplified explanation is that these are more often OH^- ions, and that they probably fit better into the lattice structure of the colloid or are more acceptable by the colloid than the positive ions, which are often larger than the negative.

Brinton and Laufer comment on this in Ref. (2) and Glasstone in Ref. (4).

The negative surfaces of the colloid attract a surrounding layer of positive ions, which may originate either from the "bulk of the suspending liquid," or from the surface of the colloid itself. The oppositely charged ions, or "counter-ions," are drawn to the colloid by electrostatic attraction, while thermal agitation or Brownian motion tends to distribute them uniformly throughout the solution. This charged system —the surface of the colloid and the neutralizing counter-ions—is called a "double layer."

If the negative charge is large, some counter-ions will be so strongly attracted that they will stick to the surface of the colloid as a firmly attached compact layer, often called the Stern layer. This layer partially neutralizes the charge and electrostatic attraction of the colloid so that the remaining counter-ions can on the average be farther away, while still being kept in the immediate vicinity of the colloid. They form the so-called diffuse part of the double layer.

The attraction of the central colloid is greatest, of course, close to itself, both because of the distance involved and also because the counter-ions near it interpose their positive charge and thus shield those counter-ions farther away. Hence, the neutralizing counter-ions are most concentrated near the colloid and become gradually negligible farther away. Similarly, negative ions of any salts present tend to be repelled from the immediate vicinity of the colloidal particles. How far away this diffuse double layer extends depends primarily on the concentration of

This is the second and final article on the use of zeta-potential control as a tool for water treatment. The first appeared in the June 26 issue of *Chemical Engineering*

Final prototype of new electrophoresis cell—Fig. 1

Detail shows the tube and solution chambers—Fig. 2

simple salts in the liquid; if their concentration is large, this distance may be reduced to a few angstroms.

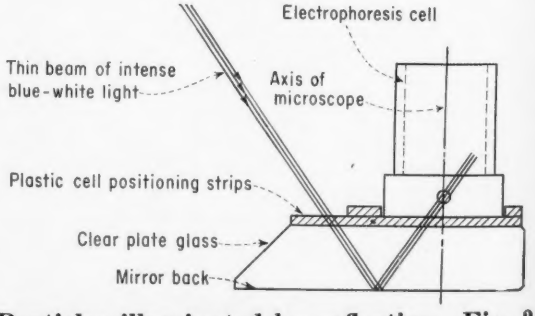
The zeta potential is the potential at the surface separating the immobile part of the double layer from the diffuse part. It is a simultaneous measure of the charge of the diffuse double layer (per unit surface of the colloid) and of its extent away from this surface. The zeta potential is therefore related to the force and distance over which the particles can repel each other and thus prevent flocculation.

This, of course, is considerably oversimplified. Verwey calls attention to the fact that the surface charge on the colloid may reflect the nature of the adsorbed capillary-active ions or the nature of the potential-determining ions (principally valency or equivalent valency) situated in the double layer, or both.

The Schulze-Hardy rule states that in the coagulation of sols, the flocculating (hence zeta-potential controlling) power of bivalent ions is approximately 20 to 80 times that of univalent ions—and the flocculating power of trivalent ions is 10 to 100 times that of bivalent ions.

When a liquid containing such charged particles is placed in an electric field, the negative particles are attracted to the positive electrode, and the counter-ions to the negative. This attraction increases with the charge on the particle. Friction between the particle and the surrounding liquid containing the diffuse double layer slows down the resulting motion toward the electrode—the greater the extent of the double layer, the lower this resistance. Therefore, particle velocity in a given field increases with both density and extent of the double layer, which, as we have just seen, are measured by the zeta potential. Hence, the velocity of a colloidal particle in an electric field is proportional to that field (volts/cm.) and to the zeta potential of the particle.

With this oversimplified picture, one might think the total charge on the colloid is directly proportional to its rate of movement in a d.c. field. Abramson and others, however, have demonstrated experimentally that this is strictly a surface phenomenon. If a particle of calcite with a ZP of −20 mv. is coated with a protein that has a ZP of −12 mv., it will migrate in a d.c. field with a velocity equivalent to a −12 mv. potential.



Particles illuminated by reflection—Fig. 3

The fundamental equation for the zeta potential of particles comparable to raw water colloids is:

$$ZP = UV_t 4\pi/D_t$$

where U is the electrophoretic velocity of the particle, and V and D are the viscosity and dielectric constant of the suspending liquid, respectively. Since V and D are constant for any given liquid at constant temperature, ZP is directly proportional to electrophoretic velocity of the particle.

Transforming voltage from electrostatic to practical volts, U is expressed as the rate of particle travel in microns/sec. per volt/cm. The microns/sec. are readily determined by timing the rate of travel of an individual colloid between known grid lines of an ocular micrometer. The volts/cm. fundamentally represent the voltage drop (in the suspending liquid) between electrodes and the effective distance in cm. between them.

Whether zeta potential is regarded as a tiny or powerful force compared with other effects, such as the downward drag of gravity, depends entirely upon the size and distance apart of the particles. Two boulders suspended side by side in a lake will show appreciable downward force due to gravity, but the repulsive force due to ZP is immeasurably small. If these boulders should be crushed to the size of beach sand, the force of gravity would be still the stronger influence. However, if these sand particles are crushed in a mortar to a size of 1 micron and less, they may remain suspended indefinitely because the ZP may produce sufficient repulsive force to prevent them from coming together, agglomerating and settling rapidly in accordance with Stokes' law.

The reasons why such a basic principle as the zeta potential has not been put to wide practical use heretofore can probably be ascribed to several causes:

- Most research has been carried out by scientists who had little interest in the commercial field.
- The electrophoresis cells presently available are so delicate as to confine their use to highly specialized laboratories.
- The technique has been so exacting, and speed of determination so slow, as to be discouraging.
- Introductory literature in the U. S. has (until recent years) been scarce.[2, 6, 8]

Newly Developed Cell Determines Zeta Potential

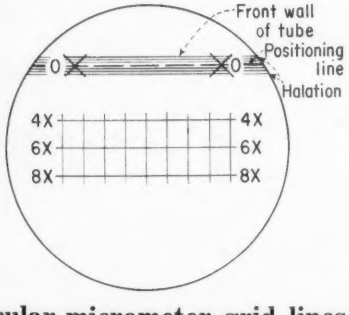
About ten years ago, we developed the calcite process of coagulation, in which alum and finely ground calcite are prereacted before being applied to the raw water. Since we had noted in this work that taste and odor removal correlated quite well with clarity of the plant effluent, we later directed our research along lines of colloid chemistry, the most promising facet of which seemed to be the zeta potential. We found that available cells were not well adapted to determining electrophoretic mobility of particles even as large as fine floc because of their thin sections. These cells were delicate, and tedious to operate, and we therefore developed a new cell and technique, using a stereoscopic microscope.

Fig. 1 shows the equipment, now commercially available, which consists of:

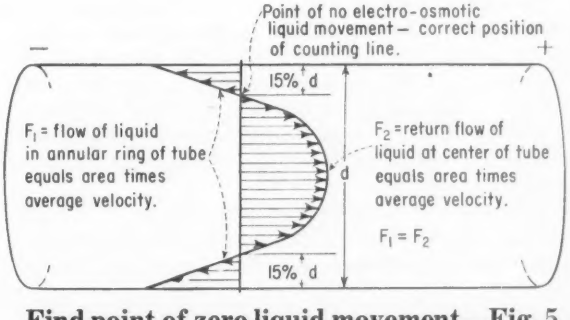
1. A stereoscopic microscope with ocular micrometer; 15× WF eyepieces; 2, 4, 6 and 8× (adjusted magnification) objectives; and a special mechanical stage. (A standard compound laboratory microscope cannot be employed with the cell.)
2. A special illuminator, producing a thin beam of intense blue-white light, with heat-absorbing filter.
3. A d.c. power supply, continuously variable from 0 to 500 v.
4. A clear plastic electrophoresis cell, equipped with platinum-iridium electrodes.
5. A cell holder consisting of a thick and highly reflective mirror for reflecting the light (45°) upward through the cell tube.
6. An interrupted-type cumulative-reading electrical timer, reading in seconds and tenths.

Fig. 2 shows the cell—a clear plastic block with a small polished tube extending through the center. The tube is connected by tapered ports to two solution chambers, one of which is sealed with a direct-coupled platinum-iridium electrode of the closed type, while the other contains an open-type electrode.

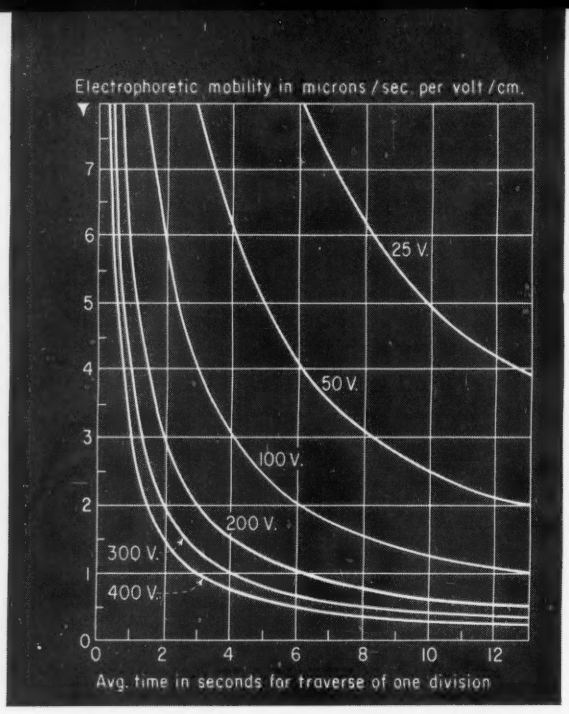
The closed electrode is positioned in one chamber, preventing all movement within the cell tube other than that induced by the impressed voltage. The other chamber is left open (or covered with a loose-fitting plastic cap) for convenience in use. This arrange-



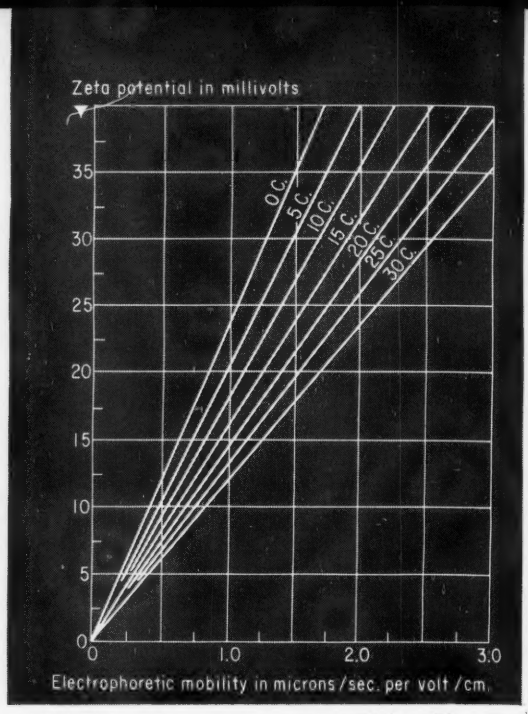
Ocular-micrometer grid lines—Fig. 4



Find point of zero liquid movement—Fig. 5



Particle velocity gives mobility—Fig. 6



Mobility gives zeta potential—Fig. 7

ment is normally employed for measuring the electrophoretic velocity of all colloids. If floc particles are to be evaluated, then two open-type platinum electrodes are preferred to permit tilting the cell back and forth until a floc particle is properly positioned for timing. The cell is supported on the holder, as shown by Fig. 3, so that the thin light beam reflects upward through the cell tube at an angle. This removes direct light from the optics of the microscope and permits particles too small for normal observation to be readily seen if they reflect light.

The cell is positioned somewhat above the top of the mirror to provide an air-gap heat barrier, and passage of the light through the thick mirror further reduces heat transmission.

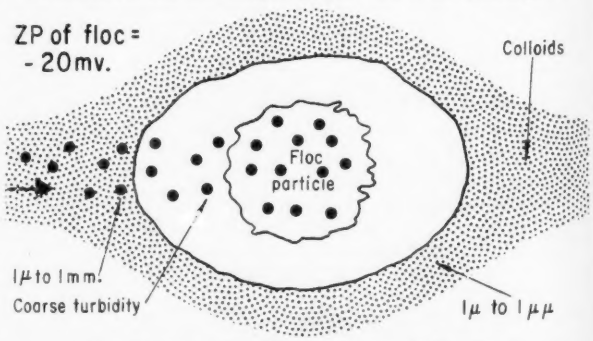
The rate of migration (electrophoretic mobility) of Bacillus subtilis can be readily ascertained with a 4 or 6-power objective and 15× WF eyepieces, although the length of this bacterium is only a few microns. Thus, this reflected light technique enables seeing minute particles, which would otherwise require 1,000 to 1,500×, at 60× or 90×.

To view colloids in any liquid, provided concentration is not excessive, the cell is removed and a drop of the suspension placed beneath the microscope on the mirror. Both raw cane-sugar juice and blood require dilution with distilled water. This technique is simple but highly effective in qualitatively appraising colloid concentrations,* and would seem to have application in industrial fields.

Fig. 4 shows a section of the tube as it is seen through the stereoscopic microscope. The 4, 6 and 8× objectives are preferable for precise work, but the 2× objective permits viewing the entire width of the tube for evaluation of precipitates. A special ocular micrometer is employed in one eyepiece, and the cell is positioned with the zero micrometer line set at the apparent (not actual) front wall of the tube. The front wall is clearly visible as a long sharp line when the microscope is focused to exact mid-depth of the cell. The difference between actual and apparent diameter is due to refraction.

If a suspended (solid) particle moves by electrophoresis in relation to the liquid, then it follows that the liquid must also move with relation to a fixed solid, in this case, the walls of the cell tube. To compensate for this movement of liquid (known as electro endo-osmosis, and manifest as a flow along the walls of the tube with return as its center), it is necessary to measure the rate of travel of discrete particles at

—Theoretical concept shows how lowering ...



At −20 mv., few colloids can reach the floc.

* A patent has been applied for, covering the projection of the image on a screen by mechanical means or by closed-circuit television.

a distance of 15% of the tube diameter from the tube wall. Fig. 5 shows this relationship in detail.

The procedure for determining the zeta potential of suspended particulate matter is as follows:

1. Fill the solution chambers with the suspension, then insert the stoppered electrode in one chamber, excluding all air bubbles. Tilt the cell to fill the electrode tube, then insert the stopper in this tube, closing the cell. Place the open electrode in the other chamber.

2. Position the cell on the holder and adjust the mechanical stage in a way that the zero ocular-micrometer line coincides with the apparent front wall of the tube as shown by Fig. 5. Use, say, the 6× eyepiece, and focus the stereoscopic microscope to mid-depth of the cell. At this point, the "positioning line" stands out sharply.

3. Connect the electrodes to the d.c. power supply, and adjust to, say, 300 v.

4. With the electrical timer, measure cumulatively the time (in seconds and tenths) required for 10 or 20 particles (situated on or very near the 6× counting line) to each traverse one micrometer division. Our basic data is therefore:

Voltage	300v.
Objective	6X
Number of particles counted	10
Total time, sec.	30.0
Temperature of sample	15C.

Fig. 6 shows curves for the 6× objective. Extend the 3.0 interval on the *X* axis (avg. time in sec.) upward to the 300-v. curve. The electrophoretic mobility is read directly as 1.40 microns/sec. per v./cm.

Fig. 7 enables conversion of this reading directly to ZP in mv. Since the temperature of the sample was 15 C., the ZP is 22 mv.—a reasonable value for raw-water colloids. If the colloids migrate toward the positive electrode, they are electro-negative.

The curves shown are typical. It is also necessary to prepare curves for the 4, 6 and 8× objectives—and log-log (instead of arithmetic) plotting produces straight lines rather than hyperbolas. The 2× objective is for calibration purposes only and the preferable objective for most work is 6×.

It is obvious that both the cell and its operation are simple. The cell may be readily cleaned with any mild detergent, and the tube with a conventional pipe cleaner.

Waterford Plant Designed for ZP Control

Zeta potentials of raw-water colloids and floc from the first flocculation bay are run each morning at our Waterford plant. Chemical dosage (alum-calcite and cationic polyelectrolyte) are adjusted accordingly.

Flocculation has remained excellent at this plant, even during the winter months, and effluent is clear and sparkling, with a colloid concentration comparable to and sometimes less than distilled water. Taste and odor removal has also been excellent.

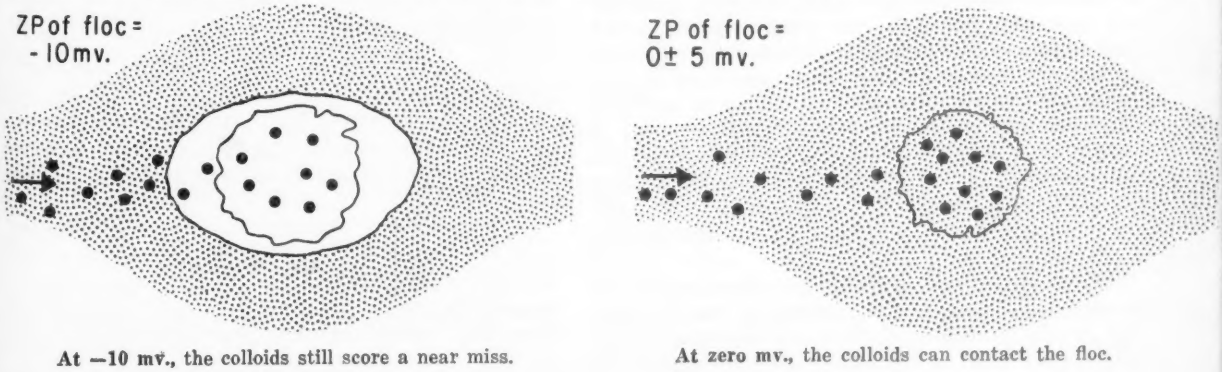
At startup (July 1960), the plant was operated in a conventional manner for one week but raw-water colloids and tastes and odors could not be removed. When zeta-potential control was instituted, colloid and taste and odor removal were effected immediately. These effects were possible because ZP of the floc was maintained at zero, ±5 mv.

When some of our best anionic coagulant aids were experimentally substituted for the cationic polyelectrolyte (which is added a few minutes after the alum-calcite mixture), floc formation remained excellent—but colloids were not removed, and neither were taste and odor. A high degree of colloid removal is completely synonomous with a high degree of taste and odor removal.

It must be borne in mind that tastes and odors reflect molecular emissions from surfaces—and that surface areas of colloids are tremendous. A cube one mm. on a side has a surface of 6 sq. mm., but if it is subdivided to 1 micron cubes (the largest size of the colloid range), the area becomes a thousand times larger, and increases a millionfold at the lower end of the colloid range.

An incidental benefit from ZP control is removal of considerably greater percentage of bacteria than with conventional coagulation. Since water bacteria have dimensions approximating a few microns, and zeta potentials approximating −15 to −35 mv., it is

. . . the zeta potential allows small colloids to contact the floc—Fig. 8.



At −10 mv., the colloids still score a near miss.

At zero mv., the colloids can contact the floc.

natural that maintaining the ZP at or near zero causes their enmeshment in the floc to a much higher degree than possible in normal coagulation. At Waterford, approximately 99.9% of the raw-water coliform organisms are enmeshed in the floc during coagulation, and are subsequently removed from the water by sedimentation.

Why Does Zeta-Potential Control Work?

A hypothesis is necessary to account for the known condition that conventional coagulation at zeta potentials of −14 to −20 mv. effectively removes the coarse fraction of turbidity (1 micron and larger), but not the fine fraction (1 micron and smaller), while at zeta potentials near zero, both fractions are largely removed.

Assume a floc with ZP adjusted to 20, 10 and then zero by appropriate additions of alum plus a cationic polyelectrolyte (see Fig. 8). This floc is veritably tumbling in a sea of colloids. At −20 mv., few colloids can reach or become imbedded in the floc because both are strongly negative. At −10 mv., the mutually repelling forces are lessened, but the colloids (as a whole) still score a near miss. At zero ZP, the colloids and floc not only do not repel one another, but when mechanical agitation brings them into contact, London-Van der Waals forces come into effect and exert mutual attraction.

The laws of force and motion seem applicable to this situation. Consider two particles of turbidity in a flocculation basin, impinging upon a single floc particle due to the mechanical mixing action of the flocculator. Assume that all three particles are electronegative with ZP values of −15 mv., that the floc particle has a diameter of 1 mm., that the coarse turbidity particle has a size of 100 microns and that the fine turbidity particle (or colloid) has a diameter of $\frac{1}{10}$ micron. The floc particle is therefore ten times the size of the coarse turbidity particle, and 10,000 times the size of the colloid. The two turbidity particles have a size ratio of 1,000:1. A sphere with a radius of 1 micron and specific gravity of 2 weighs 8×10^{-12} g., whereas a similar sphere one thousandth this size weighs 8×10^{-21}. The weight ratio is therefore 1,000,000,000 to 1.

Kinetic energy of a particle of moving mass is equal to $\frac{1}{2}\ mv^2$ and the momentum is equal to mv. Since the two turbidity particles have approximately equal velocities (a function of agitation speed), the particle with the high mass is much more capable of driving through the repelling barrier of −15 mv. or −10 mv. created by the ZP than is the colloid of low mass. A mass difference of 1,000:1 would seem to account for this condition, and the ratio of one billion to one (for the two particles in question) seems more than ample. We may readily pitch buck shot into an electric fan, but not pith balls.

There are a number of highly pertinent subjects not discussed in these articles, including the cationics (their nature, possible dangers, present availability, effectiveness and the cost aspects of zeta-potential control. Cost has been and is receiving a considerable amount of our attention. Early indications were that cost might be an almost prohibitive factor, but we now feel that our continuing development work augurs well for economical usage of the cationics for water treatment.

Many cationics now on the market (developed principally for the textile industry) leave much to be desired in effectiveness for zeta-potential control. The cost per pound, as well as percent of active ingredients are both meaningless criteria, and evaluation can only be made on a basis of cost per unit change of zeta potential.

We feel confident that when the American Water Works Assn.'s Committee on Coagulant Aids has further advanced its studies, its conclusions will coincide with ours—highly polluted raw waters cannot be successfully treated for effective colloid and taste and odor removal by the employment of only anionic or non-ionic surface-active agents.

It is hoped that this presentation will elicit further interest in this field. Continued research, particularly with waters containing highly electro-negative colloids, as well as colloids having a wide spread of ZP values, will undoubtedly show some variations in the pattern set forth. However, it is believed that this pattern, established by research and fully confirmed by operation of the Waterford plant, is basic. The zeta potential, like the force of gravity, cannot be ignored. And like the force of gravity, it is applicable to all conditions within its sphere of influence. Water coagulation is but one of them.

I am greatly debted to Prof. K. J. Mysels of the University of Southern California, and to S. A. Troelstra of Philips of The Netherlands, for their helpful comments concerning the theoretical treatment of the zeta potential in these articles.

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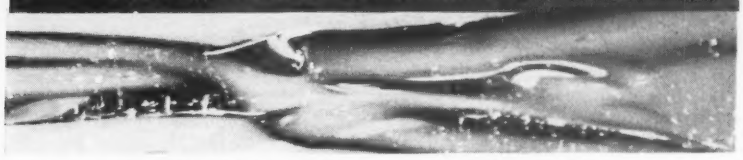
Meet the Author

THOMAS M. RIDDICK'S *biography appears on page 121*, Chem. Eng., *June 26, 1961.*



Articles in This New Series

1. Designing laminar-flow systems, June 12, 1961, p. 243.
2. Determining end of laminar region, June 26, 1961, p. 127.
3. ▶ **Turbulent Flow—A Historical Review.**
4. Scaleup of non-Newtonian turbulent flow.
5. Handling settling slurries.
6. Methods for obtaining data.
7. How to interpret data.

Turbulent Flow—A Historical Review

A summary of the articles on turbulent flow in the technical literature, including experimental data and mathematical models.

RICHARD LeBARON BOWEN, Jr., *Coated Textile Mills, Inc.**

We have pointed out that laminar $D\Delta P/4L$ vs. $8V/D$ curves cannot be predicted for non-Newtonian fluids without obtaining extensive rheological data with an instrument such as an extrusion rheometer. On the other hand, such curves could be drawn for a Newtonian fluid knowing only the viscosity taken at a single point. But, laminar-flow diagrams must be determined experimentally for each non-Newtonian material over the range to be used. This is even truer in the case of correlations for turbulent non-Newtonian flow, for here various physical characteristics of time-independent fluids may suppress the onset of turbulence. Recently, this has been clearly shown for a polymer solution where the friction factor vs. Reynolds number curve was well below curves for other polymer solutions having the same degree of non-Newtonian behavior (i.e., the same slope on the laminar $D\Delta P/4L$ vs. $8V/D$).[4] A possible explanation is that this fluid possessed a degree of viscoelasticity that suppressed but did not eliminate turbulence.

It will be well to review the prior art methods for the correlation of non-Newtonian turbulent flow data. The main difference in the various approaches has been in defining the value of the viscosity to be used in the conventional Reynolds number. Most early workers assumed that the shear-rates were high enough in turbulent flow to permit constancy in the viscosity.

One of the first attempts at non-Newtonian turbulent-flow correlation was made by Caldwell and Babbitt on slurries, using the viscosity of the suspending medium (water) in the Reynolds number.[2] This correlation was based on extensive data taken with water suspensions of clay, mud and sludge, all being plastic fluids with yield points. This produced an excellent correlation of the turbulent data. However, use of the water viscosity extended the laminar Reynolds numbers at least as high as 70,000 (for the one set of published data). With such a method, there would be different critical velocities for each material and each pipe size. The geometrical shape of the data plotted on a Reynolds number chart would be much the same as Hedstrom's chart for Bingham plastic materials.

Hedstrom[14] used the plastic viscosity in the Reynolds number. This is a constant very nearly equal to the arithmetic slope of the laminar $D\Delta P/4L$ vs. $8V/D$ data that fall on a perfectly straight line at higher values of $8V/D$ for any true plastic material. Thus, Babbitt and Caldwell's and Hedstrom's Reynolds numbers differ only by the ratio of the plastic viscosity to the viscosity of water. Both produce reasonable correlations in the turbulent region, a fact that seems to have been tacitly ignored by some recent workers.

Others have used a limiting viscosity determined at an infinite shear-rate.[11, 13] One of these produced a good correlation for data on the flow of pseudoplastic GRS latexes, but these were very nearly Newtonian ($n' =$ 0.89 to 0.985, vs. 1.0 for Newtonian fluids).[13] A third method has been the use of a "turbulent viscosity" for turbulent correlations.[1, 9, 10] Here, the friction factor is calculated in the usual manner and a Reynolds number is determined from the conventional friction factor vs. Reynolds number chart. The turbulent viscosity is then calculated from this Reynolds number, using the actual D, V and ρ. No indication is given in the published literature of the accuracy of this method, or of the constancy of the turbulent viscosity for different types of materials when calculated in this manner.

The final method of correlating turbulent non-Newtonian data is by the use of the conventional friction factor and the generalized Reynolds number of Eq. (24).[4, 6] In the earlier part of this particular work,

* For author biography, see *Chem. Eng.*, June 12, 1961, p. 248.

Equations Cited in This Article

$$N_{ReG} = \frac{DV\rho}{g_c \dfrac{D\Delta P}{4L} \Big/ \dfrac{8V}{D}} \quad (20)$$

$$D\Delta P/4L = K'(8V/D)^{n'} \quad (22)$$

$$N_{ReM} = \frac{D^{n'}V^{2-n}\rho}{g_c K' 8^{n'-1}} \quad (24)$$

$$f = 0.079/(N_{Re})^{0.25} \quad (28)^*$$

$$\sqrt{1/f} = 4.0 \text{ Log } (N_{Re}\sqrt{f}) - 0.40 \quad (31)^*$$

* These equations will appear in Part IV of this series.

the turbulent data were obtained solely from various clay and rock suspensions in water. The Reynolds number plot of the results seemed to indicate that the end of the laminar region occurred from 2,000 to 3,000 and was followed by a broad region, extending to 70,000, where the friction factor was almost constant. Maximum deviation occurred with Reynolds numbers of 5,000 to 10,000, where friction factors varied from about 0.005 to 0.008. It is important to note that, in using the generalized Reynolds number as shown by Eq. (24), the laminar data were forced to fit straight lines on logarithmic plots (part of these data are shown in Figs. 4 and 5). Straigtht lines were drawn so that they fit the middle parts of the laminar curves, but these lines fell far below the laminar data at higher values of $8V/D$. In the case of the data of Alves, et al., this straight line was about 50% below the curve that passed through the laminar data points at the highest $8V/D$. The same is true of the data of Wilhelm, et al. Thus, the value used for the viscosity term in the Reynolds number by these workers is purely arbitrary and, the higher the $8V/D$, the greater the deviation from any actual laminar value. Therefore, the scatter of the data in the turbulent region gives little indication of the usefulness of this correlation.

The published data conclusively show that some of these concentrated slurries and suspensions are Bingham plastic materials with very definite yield points.[2, 12] The laminar $D\Delta P/4L$ vs. $8V/D$ data for these Bingham fluids fall on straight lines at higher $8V/D$ values on arithmetic plots; this was conclusively demonstrated by the numerous curves for such materials published by Caldwell and Babbitt.[2] The data of Wilhelm, et al., also appear to describe a straight line at higher $8V/D$ values on arithmetic coordinates (Fig. 7). While the data of Alves, et al., could be fitted with a straight line over the area of the turbulent data, a line with a very slight curve seems to fit the points most easily (Fig. 6). (This graph was originally published with a straight line through the data.[1])

To determine the actual correlation obtained for such data when using Eq. (20), we have calculated the Reynolds numbers for the turbulent data of Wilhelm, et al., and Alves, et al., using in the denominator the laminar value of $D\Delta P/4L$ corresponding to the measured $8V/D$. A plot of these against the conventional friction factor shows that the data actually fall on separate curves, according to the pipe size (Fig. 8). It is clear that the turbulent data for Bingham plastics cannot be correlated, even for a single fluid, using Reynolds numbers defined by Eq. (20).

However, the data of Wilhelm, et al., correlate very nicely when using a constant viscosity term. Alves, et al., have shown that turbulent 18% TiO_2 data for three pipe sizes—smooth $\frac{1}{8}$-in., $\frac{1}{4}$-in., and $\frac{1}{2}$-in. (the 2-in. data must be omitted since the pipe was standard steel)—correlate remarkably well on a single straight line when using the usual friction factor and a constant viscosity term.[1] This is a very important point to resolve, for the impression may have been given that Bingham fluids can be correlated by a Reynolds number defined by Eq. (24), where the viscosity term is variable when n' varies.[4, 5, 6]

It has been stated that when correlations have been obtained using constant viscosity terms in the Reynolds numbers these fluids have become Newtonian at the shear-stresses encountered in the turbulent region.[3,4] This means that the slope of the $D\Delta P/4L$ vs. $8V/D$ laminar data must be unity. A look at any of the curves for these plastic materials will show that this is an absolute impossibility for the published data (Fig. 5). Therefore, it must be emphasized that certain non-Newtonian materials, such as Bingham plastic fluids, do correlate when a constant viscosity term is used in the Reynolds number. They do not correlate when variable viscosity terms are used in the Reynolds number.

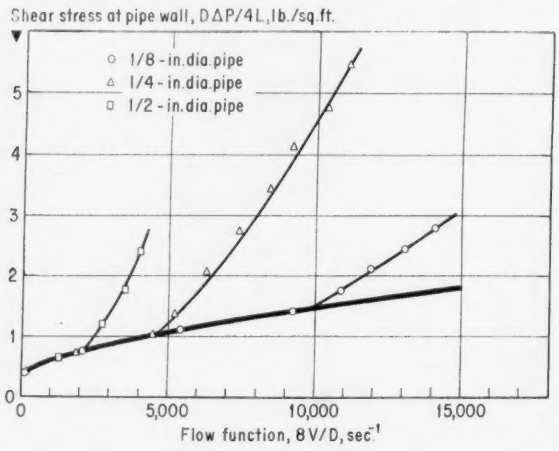
Recent work by Dodge,[3] using the generalized Reynolds number of Eq. (24) with pseudoplastic polymer solutions obeying the power law, has been published.[4] Here, very nice correlations are obtained in the turbulent region. The data actually correlate on a family of curves where the parameter is the slope n' of the logarithmic plot of the laminar $D\Delta P/4L$ vs. $8V/D$ data. The more non-Newtonian the fluid is (that is, the greater n' deviates from the value of 1.0 for Newtonian fluids) the farther the actual curve is below (when $n' \angle 1.0$) the friction factor vs. Reynolds number curve for turbulent Newtonian fluids. An equation has been derived for these curves, which is said to fit the data very well.

$$\sqrt{\frac{1}{f}} = \frac{4.0}{(n')^{0.75}} \log [N_{ReM}(f)^{1-(n'/2)}] - \frac{0.40}{(n')^{1.2}} \quad (27)$$

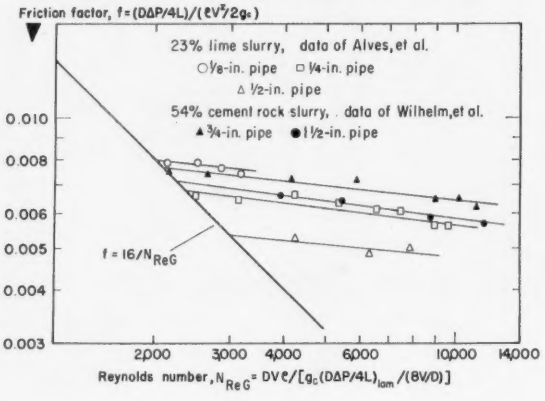
It does not apply to the anomalous pseudoplastic fluids mentioned above. The equation reduces to the von Karman equation, Eq. (31), in the case of Newtonian fluids. For pseudoplastic fluids, it appears that as the value of n' decreases, the laminar region extends farther and farther past a Reynolds number of 2,100, and with extremely non-Newtonian fluids ($n' < 0.2$), the laminar region may possibly extend up to 4,000.

Other recent work by Shaver[7] with pseudoplastic polymers is at variance with the above results, for the turbulent region.[8] A similar family of curves is obtained for different values of n', and these appear to fit a modified form of the Blasius equation, Eq. (28), with n' occurring in both the exponent and the constant. It has been pointed out that, unfortunately, the only data Shaver used that had an n' of less than

Plot of data of Wilhelm—Fig. 7



Reynolds number vs. friction factor plot for two slurry systems—Fig. 8



0.7 were for the anomalous fluid reported by Dodge.[4] However, even for a value of $n' = 0.7$, the two results are at a variance, the Eq. (27) of Dodge giving friction factors from 40% to 140% higher than Shaver's equation. However, it is to be noted that Dodge used viscometric data taken with an extrusion rheometer, which were as much as 20% lower than the laminar conditions indicated by the actual pipeline tests. In only one run ($n' = 0.726$) were the viscometric data equal to the laminar pipeline data. It must further be emphasized that Dodge's Eq. (27) is based on only one pseudoplastic solution (carboxymethylcellulose, i.e., Carbopol). More work is obviously needed.

In summary, we see that so far no universal correlation of turbulent data has been obtained for all non-Newtonian fluids. For pseudoplastic or dilatant materials that obey the power law, a correlation may perhaps be obtained by plotting the usual friction factor vs. a generalized Reynolds number such as defined by Eqs. (20) or (24). If the material is of a plastic nature such that it is similar to an ideal Bingham material, wherein higher values of $D\Delta P/4L$ vs. $8V/D$ produce a straight line on an arithmetic plot, the turbulent data may be correlated by plotting the friction factor against a Reynolds number containing the plastic viscosity as the viscosity term. However, we have seen that it is difficult to tell where turbulence starts with different pipe sizes. On the other hand, no exact method has been suggested for the many materials that are not similar to one of these classic fluids. Such materials include many pasty dispersions of solid materials, certain polymer solutions, many dilatant systems, and some other classes.

It has often been stated that a great many non-Newtonian fluids, possibly the majority, adhere to the power law relationship over wide ranges of shear-rates (10- to 1,000-fold).[4,5] It is our opinion that the large majority of non-Newtonian materials do not obey the power law, and that serious errors will be introduced by forcing the data to fit any power law equation. We have illustrated several cases where errors of 50% or more have been produced by this method. One must conclude that the existing methods of correlation of turbulent non-Newtonian data are applicable only to certain specific fluids that obey several special classic equations.

Nomenclature

D	Pipe or tube dia., ft.
f	Fanning friction factor (dimensionless), $(D\Delta P/4L)/(\rho V^2/2g_c)$.
g_c	Gravitational constant, 32.2 (ft./sec.)/sec.
K'	Fluid consistency index, defined by Eq. (22).
L	Pipe or tube length, ft.
n'	Non-Newtonian rheological constant, defined by Eq. (22).
N_{Re}	Conventional Reynolds number (dimensionless), $DV\rho/\mu$.
N_{ReG}	Generalized Reynolds number (dimensionless), defined by Eq. (20).
N_{ReM}	Reynolds number (dimensionless)) used by Metzner and Reed, defined by Eq. 24.
ΔP	Pressure drop, lb./sq. ft.
V	Mean linear velocity, ft./sec.
ρ	Density, lb./cu. ft.
μ	Viscosity of a Newtonian fluid, lb./(sec.) (ft.).

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Vacation–2 Weeks in Another Town

It's the season of the sun again—time to check road maps, transportation schedules and sportswear shops. And, chances are, your firm is actually encouraging you to relax.

Vacation time for millions of Americans—thousands of them engineers in the chemical industries and their families—is with us again. Once more, bold and not-so-bold plans are mulled over, argued about, revised and accepted within the family circle. But some elements of our playful national pastime are seldom considered in the excitement of getting away from it all.

To explore some of these ignored elements, we called on *Chemical Engineering's* regional editors, Tom Arnold and Marty Robbins, and McGraw-Hill reporters scattered across vacationland. We sent them out to ask chemical and oil companies, pharmaceutical and petrochemical firms, just what their policies were on granting vacations to their engineers. Our field men probed these policies so that you can have a wider measure than just that of your own company of annual paid recreation leaves.

How Much Time Do You Have?

One of the first questions of interest in considering vacation benefits is the length of vacation for a given time of service. You may believe that this is pretty uniform in the CPI, and in one respect it is. But there are wide varieties in length and application of vacation time among companies.

The uniformity in vacations occurs in the "standard" two-week paid periods. To the company, the two weeks is actually ten working days; but coupled with the adjacent week-ends, it of course means a full two weeks off for you. Most companies we queried grant the two-week vacation after one year of service—that's the uniformity we mentioned. But there are some exceptions even to that practice.

For example, a West Coast space-age firm, which employs many chemical engineers, grants the two weeks after four months of continuous service. One large chemical company gives proportionately shorter vacations to its employees who haven't qualified for the full two weeks granted after a year's service. There, if you are hired in January, you have three days' vacation due at the beginning of the vacation year in April. Another smaller firm gives its engineers two weeks' vacation after six months of service, if they have joined the firm before the vacation year starts.

One Texas processing firm has a somewhat more generous "standard" for its vacations—13 working days after one year of employment. (Knowing those Texas distances, though, couldn't that just be traveling time to get across the state?)

What Seniority Brings

The real departures from uniformity, in service vs. length of vacation, occur beyond the junior years with a firm. The same company that grants 13 working days after one year, for example, continues this regular period through the twenty-fifth year, when it becomes 16 working days. But the firm also has a merit vacation plan after five years, with five days merit at five years, ten days merit at ten years, etc.

More typical, perhaps, is the practice of giving three

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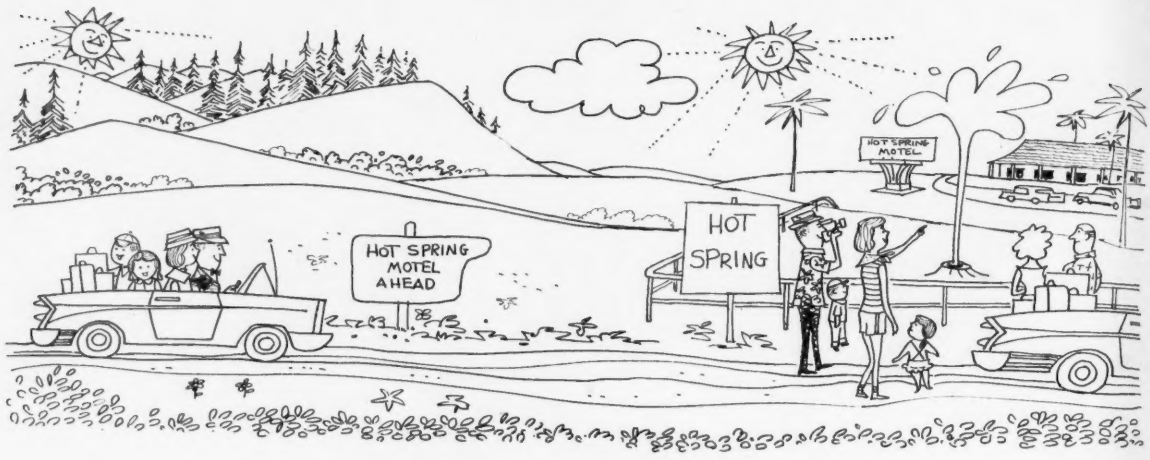


weeks' vacation after either 10 or 15 years; four weeks is usually allowed after 20 years. Bonus vacations sometimes are tacked on for long-term service, as in the case of a large process engineering and construction firm, which awards an extra week in the calendar year following an engineer's twentieth year, two extra weeks following the silver anniversary.

Although few companies appear to do it, at least one respondent to the *CE* survey indicated that its vacation policies were rather flexible, depended to a large extent on the individual worker. This firm, however, is small in comparison with most of the other companies that were questioned. It can devote more individual attention to a merit program.

Whatever the policy, this recreational benefit must cost companies heavily in terms of engineers' salaries alone. Few firms wanted to give a direct estimate, but one large company said that it amounted to roughly 5.3% of its engineers' pay. If you figure about 40,000 chemical engineers at EJC's median $10,000/yr. salary, this represents a $20-million annual investment to the employers of these engineers. That's a horseback guess, of course, and in any case, as one firm pointed out, "We don't hire additional help; the others team up to carry the work load."

Companies Are Vacation Advocates

No matter what it actually costs a chemical company, it almost certainly either tacitly or explicitly encourages the taking of vacations. Sometimes the tacit aspects of these policies are "negative," e.g., few firms allow their engineers to carry vacation time over into a succeeding year, most won't allow you to take pay in lieu of vacation.

But again, there are exceptions. One of the giants of the industry allows its employees of 25-years and over tenure to carry as much as two weeks over to the following year, thus permitting a six-week vacation. And several companies mentioned that in emergencies —one firm said only by permission of its operating divisions' chief officers—salary could be paid for vacation time lost. Another exception followed by most is that vacation untaken when you leave a firm is paid for.

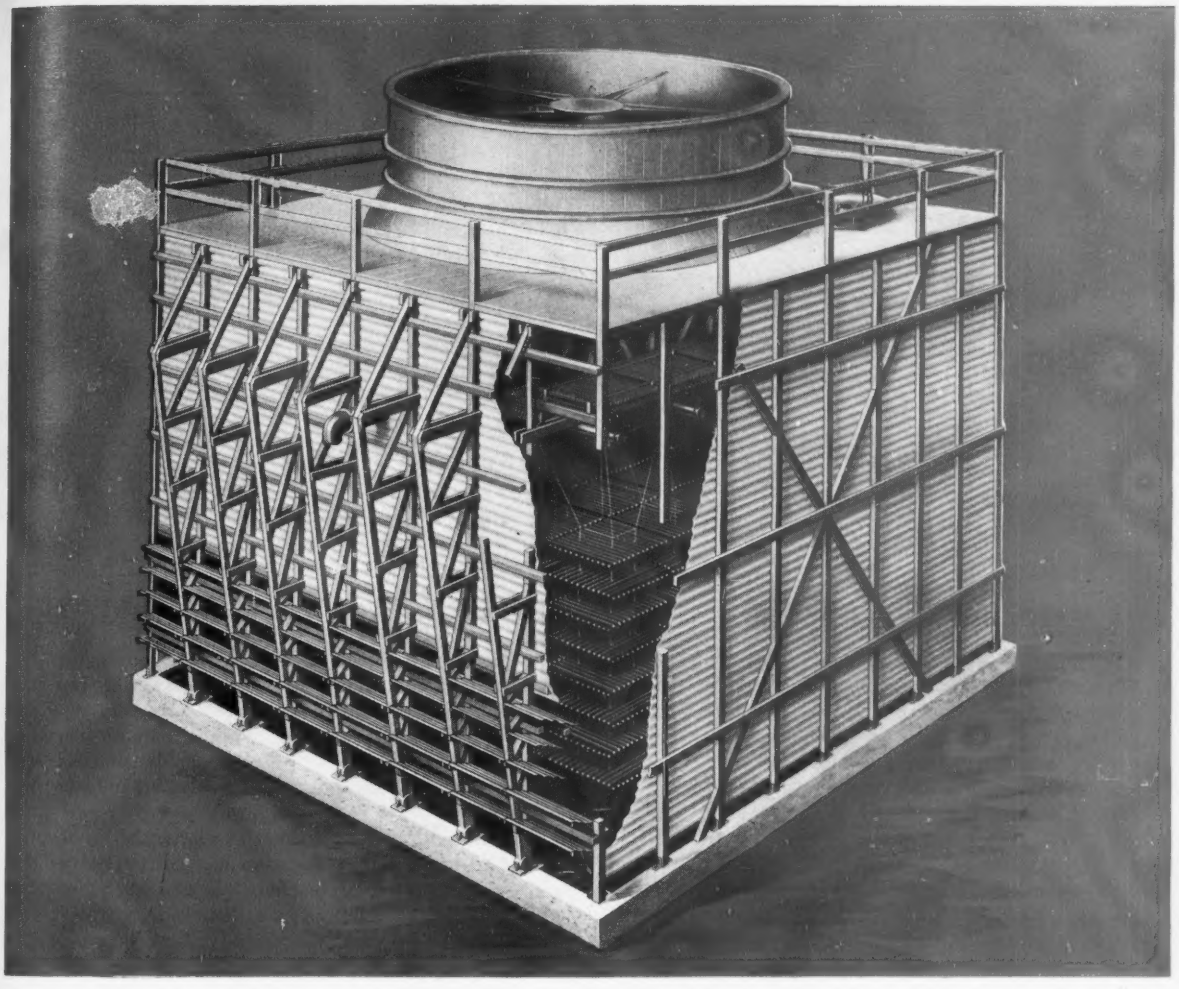
Encouragement for vacationing is fairly universal in the industry, however, and you're familiar with most of the reasons why. The recreation of mind and body, most firms feel, is well worth their encouragement. Typical active measures to stir interest include use of house organs and supervisors' word of mouth. One petrochemical company has its accounting department send around a reminder to supervisors toward end of the vacation year to make sure everyone participates.

While actively pushing a vacation, the company usually has definite ideas about when an employee should take it. For example, though many firms say that an employee may take it whenever he wishes, there are as many who modify it by saying anytime, as long as it fits operating requirements, other company plans. Others limit vacationing to only a portion of the year, presumably during off-peak operating periods.

Lumped or Distributed Leave

Many companies prefer that an engineer take all the vacation that's due him in one package. The reason: says one firm's spokesman, "It takes at least four days for an engineer to unwind, and then the vacation really starts. If he takes only a few days off at a time, it destroys the value of vacationing." On the other hand, absence for long periods may hinder the firm's operations. One firm doesn't permit its engineers to take more than two weeks at a time, even if they have more coming.

Other firms are quite lenient and flexible. A large chemical company headquartered in the East encourages its employees to take vacations when and how they want them. And many firms that claim one week is the shortest they will allow also admit that under special circumstances they will permit other arrangements. Only a few, perhaps for scheduling reasons, allow their engineers to take three- or four-day weekends.



New idea...no structural internals

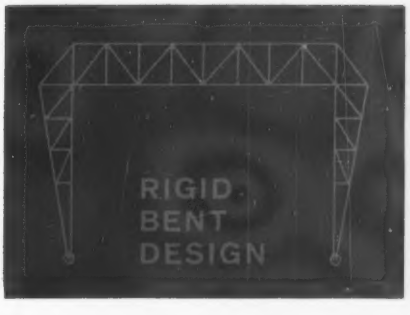
The *interior* of this new Foster Wheeler cooling tower is *completely free of structurals* below the roof trusses.

It is Foster Wheeler's new Rigid-Bent design featuring tapered built-up columns outside the tower sheathing, away from the moist, corrosive atmosphere within.

In every application, particularly where water chemistry and biological attack are serious problems, the FW Rigid-Bent design offers . . . isolation of vertical structurals from corrosion and biological attack . . . and uncommon ease of inspection, maintenance and replacement of all parts.

Space requirements and operational characteristics are the same as those attainable with older designs. Increased capacity by the addition of cells is no problem. Structurals are easily inspected and repaired during tower operation.

If you are currently considering an installation, let us provide you with further information. Write to Dept. CT, Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.



All tower internals are suspended from roof trusses. Cable-hung fill racks are quickly lowered to ground level for inspection and maintenance.

FOSTER FW WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

This year, of course, many manufacturing and service companies granted special four-day weekends in conjunction with Memorial Day and the Fourth of July. What does the chemical industry say about this? One small California firm awarded both, but its employees had to report to work on the Saturdays following each. Others grant a "floating" holiday at Christmas or Thanksgiving.

More Time and Money

And speaking of holidays, as separate from earned vacation time, most chemical industry firms seem to grant seven to eight paid holidays. Since some of the firms operate throughout the nation, holidays may vary from one region to another because of local custom, but all employees receive the same number.

Sometimes, of course, you may be a little short of cash when you leave for your vacation, so we thought it pertinent to ask about salary advance for the period of your vacation. Most of the firms we questioned do advance salaries; others will arrange to mail a check that would come while you are away; still others have a firm policy of no advance.

The travel sections and resort ads from many foreign ports-of-call beckon to many Americans these days. But the problem of going abroad is that of time. Can you actually squeeze in the necessary travel time and still spend any time in the places you wish to visit. Some can do it by tacking on a leave-of-absence with their vacation. The pattern here often seems to be that it's an individual matter, to be taken up with your supervisor.

There is one other form of acceptable flight from your engineering duties, other than vacation, leave-of-absence and holiday. That is the sabbatical. Many companies avered that no sabbaticals or other long leaves of absence with pay were granted. One firm had no policy. But three of the processing firms do award top personnel with such leaves, particularly, said one, for schooling and government service.

So have fun! Maybe we'll see each other on the road.

ASEE MET IN BLUEGRASS STATE

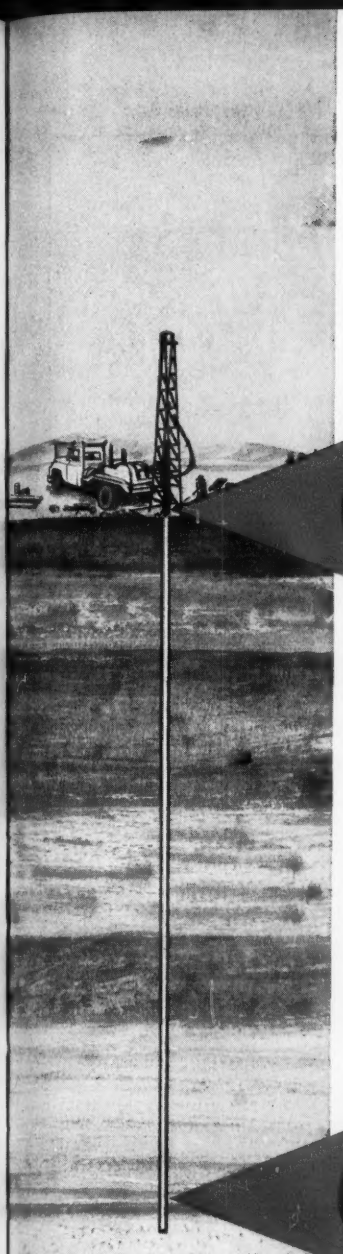
Late last month, members of the American Society for Engineering Education met in Lexington surrounded by the lush green campus of the University of Kentucky. At the society's sixty-ninth annual meeting, chemical engineering educators met to discuss and argue some of the trends in curricula and industry requirements.

On the first day of formal sessions, the underpinnings of engineering education were discussed by the chemical engineering teachers. Significantly, besides the traditional roles of mathematics, physics and chemistry being emphasized, the fourth paper of the session considered the role of humanities in undergraduate preparation.

Detailing the role of mathematics in the kit of the modern engineer's tools, Prof. H. S. Mickley of M.I.T. spoke of two parts it plays: formulation and evaluation of performance of the mathematical model of a physical and chemical system. Mickley pointed out that even in the advanced undergraduate programs, the problems attacked are shallow and the physical situation isn't emphasized. His conclusions: more advanced mathematics must be included in the curriculum because the chemical engineer needs it to teach himself other areas, as well as handle his own work.

This view was reiterated by Prof. W. R. Schowalter of Princeton University in describing the role of physics. Said Schowalter: "Physics contributes to a chemical engineer's education in three ways—cultural enrichment, practical foundations and future investment." He emphasized that each of these three ways was scorned or considered too briefly in engineering courses. Yet, with the pace of technology, a good physics base, including "modern" physics, is the only bootstrap to the future for a man.

R. W. Moulton of the University of Washington observed that the trend to more science was also evident in the chemistry curriculum, cited the increasing emphasis on the more-mathematical physical chemistry, less emphasis on the descriptive and analysis courses.



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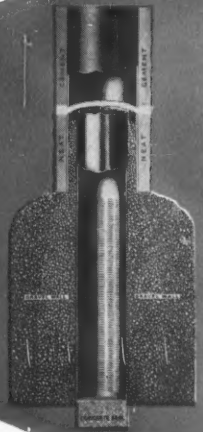

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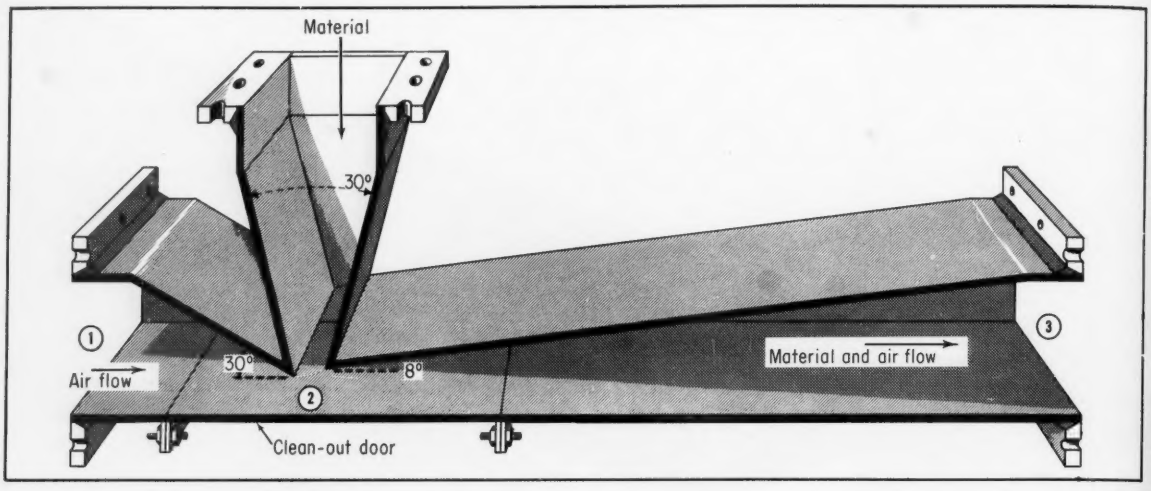


DESIGN A VENTURI FEEDER FOR DRY BULK MATERIALS

The Venturi feeder is a low-cost, easily fabricated, low-maintenance device for introducing material into an air stream.

Winner of the May Contest*
EDWARD J. GIBBONS
Colgate-Palmolive Co., Jersey City, N. J.

In cases where dry bulk materials are being handled in an air stream or where they can be introduced into a process in an air stream, consideration should be given to the use of a Venturi feeder.

This is a simple device. It is low in cost, light in weight and can be fabricated by a sheet-metal shop. A typical Venturi feeder is shown in the illustration and its proportions will be developed in the accompanying design example.

It is easy to design such a feeder if a few fundamental ideas are kept in mind.

1. Continuity of air flow Q exists so that $Q_1 = Q_2 = Q_3$ (neglecting side entry of air).
2. The velocities V will be such that $V_1 = V_3$, while V_2 will be much higher.
3. Total pressure at any point must equal the sum of the static pressure h, plus the velocity pressure h_v.
4. Total pressure at any point is always the total pressure at the next adjacent point downstream plus the losses between these points.
5. Design should be from the exit end toward the entry end.

The following example will illustrate these principles:

Design a Venturi feeder to handle 600 lb./hr. of light dry powder for delivery into a system having 2-in. water gage static pressure. Neglect temperature effects and any friction loss downstream from the Venturi.

Referring to the illustration, the important points are numbered 1, 2 and 3. Start the design at Point 3.

$$Q = \frac{600}{60} \times 50 = 500 \text{ cu.ft./min. of air needed.}$$

Note: 50 cu. ft./min./lb. of dry material is a safe air quantity for conveying, and 3,000 ft./min. is a safe velocity.

$$A_3 = Q_3/V_3 = 500/3{,}000 = 0.1667 \text{ sq.ft.} = 24 \text{ sq.in.}$$

A 4.9-in.-square duct will give this area.

At Point 3, total pressure

$$h_{t3} = h_{s3} + h_{v3}$$
$$= 2 + \left(\frac{3{,}000}{4{,}005}\right)^2 = 2.56 \text{ in.}$$

At Point 2,

(Turn page)

COMING AUGUST 7
Seal Packed-Column Redistributor With Lead Ring
By B. B. Klima, June Contest Winner

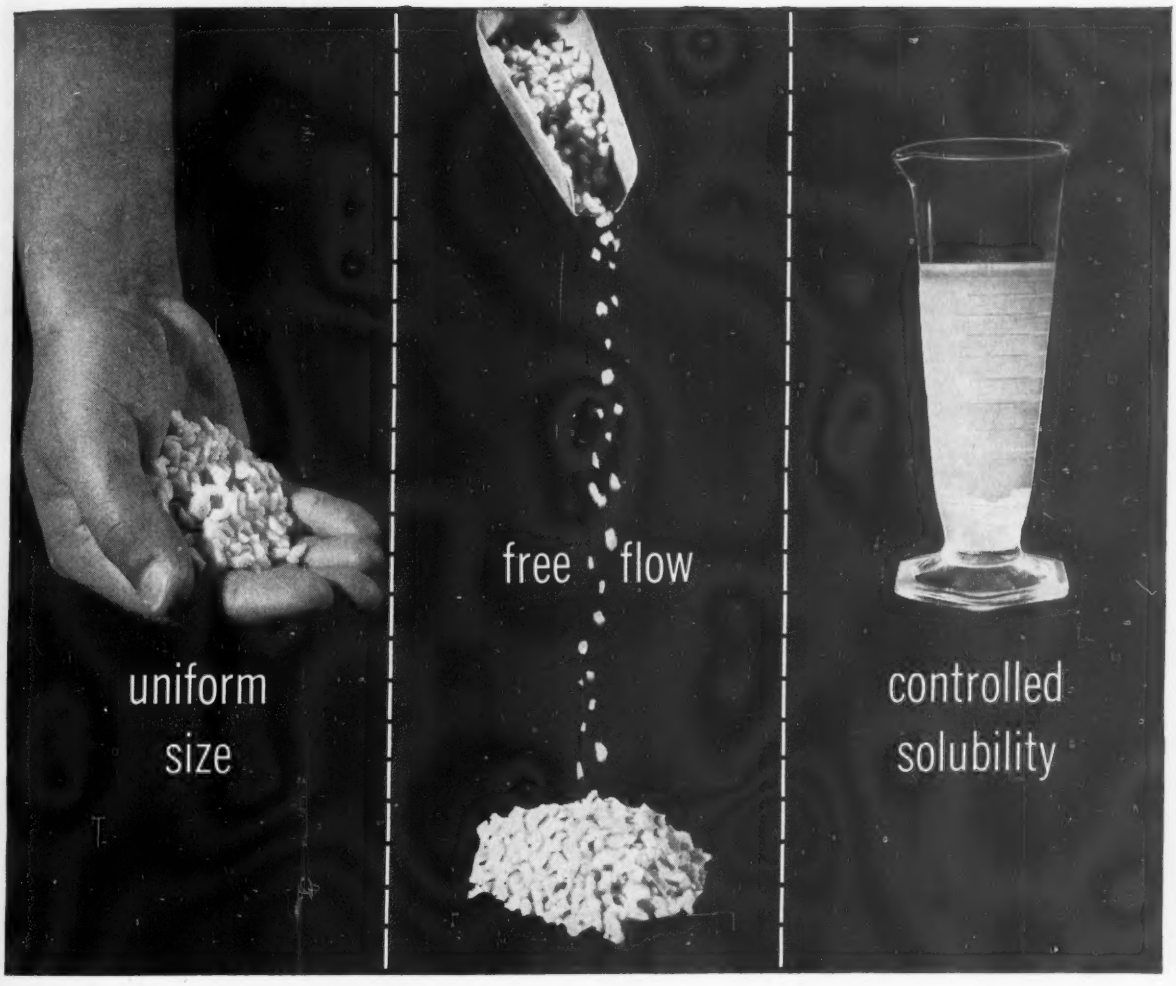
***How Readers Can Win**

$50 Prize for a Good Idea—Until further notice, the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for publication in the Plant Notebook. Each period's winner will be announced in the second following issue and published in the fourth following.

$100 Annual Prize—At the end of each year, the period winners will be rejudged by the editors and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant Notebook Editor, *Chemical Engineering*, 330 W 42 St., New York 36.



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$$h_{V2} = h_{V3} + \frac{h_{s3} - h_{s2}}{1 - K_1}$$

where K_1 is the loss coefficient for an 8° Venturi with a side entry and is equal to 0.2.

$$h_{V2} = \left(\frac{3{,}000}{4{,}005}\right)^2 + \frac{2 - (-0.05)}{1 - 0.2} = 3.12 \text{ in.}$$

and $V_2 = \sqrt{3.12} \times 4.005 = 7{,}100$ ft./min.

$$A_2 = \frac{500}{7{,}100} \times 144 = 10.10 \text{ sq.in.}$$

Since one side was 4.9 in., throat height = 10.10/4.9 = 2.06 in.

Finally, at Point 1

$$h_{t1} = h_{V1} + h_{s2} + (1 + K_2) \times (h_{V2} - h_{V1})$$

where $K_2 = 0.075$ convergence loss factor for a 30° entry angle.

$$h_{t1} = \left(\frac{3{,}000}{4{,}005}\right)^2 + (-0.05) + (1 + 0.075)\left[3.12 - \left(\frac{3{,}000}{4{,}005}\right)^2\right] = 3.27 \text{ in.}$$

$$\text{Fan brake hp.} = \frac{62.3 \times \text{cu.ft./min.} \times h_{t1}}{12 \times 33{,}000 \times E}$$

$$= \frac{62.3 \times 500 \times 3.27}{12 \times 33{,}000 \times 0.7} = 0.370 \text{ hp.}$$

Throat-hole width is made as wide as the Venturi body (4.9 in. in this case) and its length is made equal to throat height (2.06 in.).

With a Venturi feeder, it is also possible to take material from apparatus under vacuum as, for example, a dust collector.

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ROBERT W. MOORE
Attleboro Refining Co., Inc., Attleboro, Mass.

The usual method of mounting cloth bags on filter-press screens, such as are used on a Sweetland or other pressure-type filter press, is an expensive and time-consuming operation. Usually, the leaves are sent to an outside skilled processor for machine- and hand-sewing of the bags.

We have found in our plant that staples can replace hand sewing in this operation. They should be of some corrosion-resistant material, such as stainless steel or brass.

This method enables an unskilled worker to mount the bags rapidly, and the covers are as securely fastened and tight as they are when hand sewn.

Correction

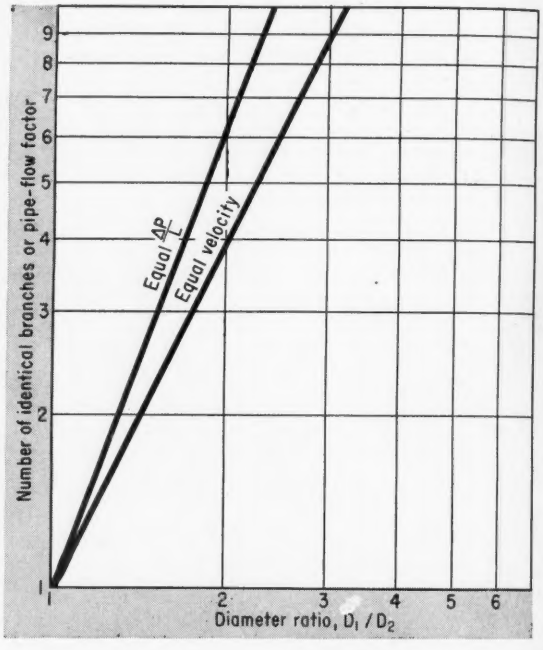
In the article "Double Rupture Disks Cope With Severe Conditions," May 15, page 182, the second sentence of the fourth paragraph should read "14 psi. at 900 F."

TEST YOUR CEQ

ROBERT LEMLICH

Can an ideal gas be subjected to an isothermal, isentropic, batch process? Prove your answer.

Answer on page 162



MANIFOLD SIZING AND PIPE SCALE-UP DONE GRAPHICALLY

BERNARD KOUZEL
Union Oil Co., Anaheim, Calif.

In the design of manifold piping systems, the size relationship between a number of identical small lines and the large common header to which they are joined must be determined.

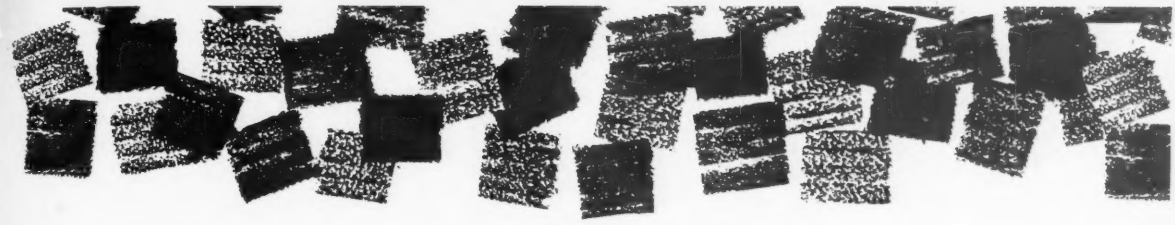
This problem is usually solved on a basis of equal flow velocity in all lines so that the flow area of the header is equal to the total flow area of the manifold system. This can be expressed mathematically as follows:

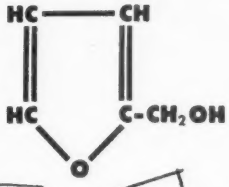
$$N D_2^2 = D_1^2$$

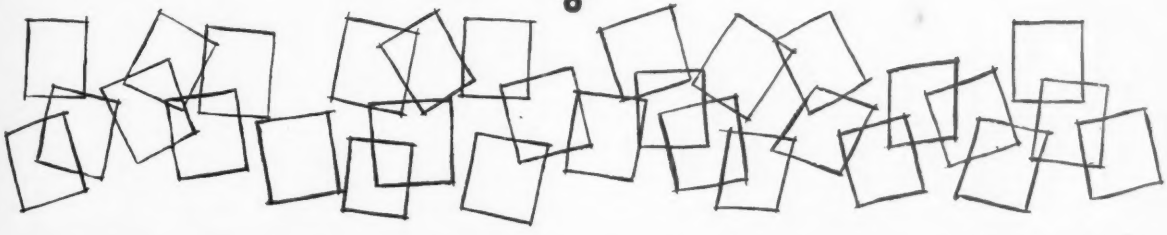
where N is the number of identical parallel lines of diameter D_2 joined to a header of diameter D_1. This equation can be solved to give:

$$N = (D_1/D_2)^2$$

A plot of this on log-log paper yields a straight line







QO® FURFURYL ALCOHOL AS A RESIN MODIFIER

Furfuryl alcohol (FA)® has a marked effect on the properties of urea-formaldehyde, phenol-formaldehyde and epoxy resins, increasing the value of these resins in specific areas of application. Many industrial uses are based on the "plus" factor to be found in furfuryl alcohol modified resins.

FA CONTRIBUTES DESIRABLE PROPERTIES TO:

1. **UREA FORMALDEHYDE RESINS**
   by improving gap-filling, craze resistance, stability to heat and aging and by lowering gas evolution. In addition, FA improves the relationship between pot life and curing speed.
2. **PHENOL FORMALDEHYDE RESINS**
   by increasing the resistance to alkali attack while retaining the acid resistance of phenolics.
3. **EPOXY RESINS**
   by functioning as a reactive solvent and increasing the flexural strength of the final product.

Specific questions invited. For general information about QO furfuryl alcohol, write for Bulletin 205.

The Quaker Oats Company

CHEMICALS DIVISION

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with a slope of 2.0 as shown in the preceding figure.

Another approach to manifold sizing is the concept of equal unit pressure drop, $\Delta P/L$, in all lines. Note that the equal-velocity criterion will give a branch-pipe unit pressure-drop higher than that in the header because the same velocity is maintained in a pipe of smaller diameter.

A simple relationship covering the design for equal pressure drop can be derived from the Fanning equation and the assumption that the friction factor in the turbulent range is a function of Reynolds number to the −0.2 power. The Fanning equation can then be written in simplified form as:

$$\Delta P/L = KQ^{1.8}/D^{4.8}$$

where K is a constant depending on the nature of the fluid and Q is the weight or volumetric flow rate.

On the basis of equal pressure drop:

$$Q_1^{1.8}/D_1^{4.8} = (Q_1/N)^{1.8}/D_2^{4.8}$$

This equation can be solved to give:

$$N = (D_1/D_2)^{2.667}$$

A log-log plot of N vs. D_1/D_2 is a straight line with a slope of 2.667. This line is also shown on the figure.

It can also be shown that the relationships developed above will hold for the case where a given size of pipe is to be scaled up or down to accommodate a change in flow rate. Therefore, our figure serves a dual purpose and the ordinate can be labeled both "number of identical branches" and "pipe flow factor."

Examples of the use of the plot are as follows:

1. What header size is required to handle the flow from four 1½-in. Sch. 40 pipes (I.D. = 1.61 in.) based on equal velocity and equal unit pressure drop?

For four parallel lines, the plot shows a diameter ratio of 2.0 on the equal-velocity basis and 1.7 on the equal pressure-drop basis. Then the header diameter would be 2.0 × 1.61 = 3.22 in. and 1.7 × 1.61 = 2.74 in. for the respective cases.

2. For a given pipe size and flow rate, what increase in diameter is required for a twofold increase in flow rate on the basis of equal velocity and equal $\Delta P/L$?

The figure shows, for a pipe flow factor of 2, a diameter ratio of 1.41 and 1.30 for the respective cases.

SEMIQUANTITATIVE TEST CHECKS FOR IMPURITIES

ROGER T. JOHNSON
California Research Corp., Richmond, Calif.

Frequently, it is necessary to hold certain impurities in a recycle feed stream to a reactor below a stipulated concentration, to avoid inhibition of the reaction. In such a case, it might be possible to make a semiquantitative check with an appropriate spot test, as described in Ref. (1) for use as a color comparison.

As an illustration: a secondary alcohol is recycled to a liquid-phase dehydrogenator. This alcohol is contaminated with *p*-phenylene diamine (*p*PDA) which inhibits the dehydrogenation and must be held below "x" ppm.

To check the concentration in the recycle stream, a test solution is made up of "x" ppm. *p*PDA in the pure alcohol. Two cc. each of test solution and the recycle stream are placed in separate test tubes and acidified with a few drops of acetic acid. Two cc. of aniline water (one drop of aniline per 50 cc. water) are added to each test tube. A few tenths of a gm. of potassium persulfate are added, and both test tubes are shaken well for several seconds. The intensity of blue color is immediately compared, since it fades quickly.

A lighter blue color in the recycle sample indicates *p*PDA concentration is below the tolerable limit. It may be necessary to dilute both the test sample and recycle sample with equal proportions of pure alcohol before the test, to give a color intensity for easiest comparison.

This is an adaptation of the spot test described on page 348 of Ref. (1). Other spot tests from the same source could conceivably be used in a similar fashion to provide a quick check on a wide variety of compounds.

Reference

1. Feigl, F., "Qualitative Analysis by Spot Tests," Nordemann Pub. Co., Inc., New York, 1939.

Answer to Test Your CEQ

By the First Law of thermodynamics,

$$dE = dQ - dW \quad (1)$$

Combining with the Second Law, we have

$$dE = T\,ds - P\,dV \quad (2)$$

For an isentropic process, ds is zero, so that

$$T\,ds = 0 \quad (3)$$

Now, by kinetic theory, the internal energy of a gas depends only on its temperature, regardless of the process. Therefore, if dT is zero,

$$dE = 0 \quad (4)$$

Combining Eqs. (2), (3) and (4),

$$P\,dV = 0 \quad (5)$$

This means that dV is zero or that V is constant. Since T is also constant, P must be constant because

$$PV = RT \quad (6)$$

Alternatively, one can arrive at the same conclusion by setting $ds = 0$ and $dT = 0$ in the entropy equation for an ideal gas, which is

$$ds = c_p d \ln T - R d \ln P \quad (7)$$

Either way, we have no change in P, V or T. Thus we have no process taking place! Accordingly, our answer is "No."

What's News in Chemicals...

What comes out here depends on you...

Enjay tailors its production to fit your needs. Over the years it has pioneered in the development of many important new compounds to meet the changing demands of the chemical industry—products like isooctyl alcohol, decyl and tridecyl alcohols, and BUTON resins, to name but a few.

Latest in this series is new Enjay hexyl alcohol. Of particular interest to vinyl plastic compounders are the phthalate esters of hexyl alcohol. Their good solvating properties make them highly efficient as calendering aids. Hexyl alcohol has other important applications as a raw material for flotation agents, lubricant additives, degreasing fluids, brake fluids and agricultural chemicals. For specifications on the full line of Enjay alcohols, or other high quality chemicals, write to Enjay, 15 W. 51st Street, New York 19, N. Y.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

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ENJAY CHEMICALS

CALCULATE PRESSURE DROP FOR FLOWING GASES FROM TABLES

FRANK LIPINSKI

Hydrocarbon Research, Inc., New York, N. Y.

The tables presented here allow quick calculation of turbulent-flow pressure drops for the gases indicated. Use Table I for methane, oxygen, and air or nitrogen. Use Table II for other gases.

To calculate pressure drop in psi./100 equivalent ft. of pipe, pick the appropriate four constants for the flowing conditions and multiply them, i.e.,

$$\Delta P = K_1 \times K_2 \times K_3 \times K_4$$

These tables are limited to pressure drops of 10% of the upstream pressure or less. Results are comparable to those calculated by using the Fanning friction factor for clean steel pipe.

Use Table I for methane, oxygen, air or nitrogen—Table II for other gases.

TABLE I

Flow, Lb./Hr.	K_1 Oxygen	K_1 Air or Nitrogen	K_1 Methane
30	0.000225	0.000243	0.000432
40	0.000384	0.000415	0.000736
50	0.000578	0.000625	0.00111
60	0.000814	0.000880	0.00156
70	0.001080	0.00117	0.00209
80	0.001390	0.00149	0.00256
90	0.001710	0.00185	0.00329
100	0.00208	0.00225	0.00400
120	0.00271	0.00293	0.00520
140	0.00390	0.00422	0.00749
160	0.00499	0.00540	0.00956
180	0.00622	0.00673	0.0119
200	0.00750	0.00810	0.0143
250	0.0115	0.0124	0.0220
300	0.0159	0.0172	0.0304
350	0.0222	0.0229	0.0407
400	0.0270	0.0292	0.0518
450	0.0338	0.0365	0.0649
500	0.0408	0.0441	0.0780
550	0.0488	0.0528	0.0935
600	0.0575	0.0622	0.110
650	0.0662	0.0716	0.127
700	0.0758	0.0820	0.145
750	0.0850	0.0920	0.163
800	0.0972	0.1050	0.186
850	0.01090	0.118	0.209
900	0.121	0.131	0.234
950	0.1295	0.140	0.248
1,000	0.1470	0.159	0.283
1,500	0.313	0.338	0.599

Flow, Lb./Hr.	K_1 Oxygen	K_1 Air or Nitrogen	K_1 Methane
2,000	0.529	0.572	1.010
2,500	0.791	0.855	1.690
3,000	1.125	1.215	2.160
3,500	1.501	1.625	2.88
4,000	1.915	2.070	3.67
4,500	2.28	2.460	4.36
5,000	2.90	3.13	5.56
6,000	3.79	4.10	7.26
7,000	5.39	5.83	10.40
8,000	6.92	7.48	13.25
9,000	8.58	9.28	16.40
10,000	10.4	11.25	19.95
12,000	13.6	14.7	26.0
14,000	19.6	21.2	37.6
16,000	25.0	27.0	47.9
18,000	31.1	33.6	59.5
20,000	37.5	40.5	72.0
25,000	57.4	62.0	110.0
30,000	79.1	85.5	151.5
35,000	129.5	140	248
40,000	135.0	146	268
45,000	169.0	182.5	323
50,000	205	221	392
60,000	288	311	552
70,000	379	410	726
80,000	487	526	932
90,000	606	655	1,160
100,000	735	795	1,410
150,000	1,550	1,690	2,990

Pipe I.D. In.	K_2
1.049	193.
1.610	85.7
2.067	25.9
3.068	3.84
4.026	1.0
6.065	0.142
7.98	0.0363
10.02	0.0120
11.94	0.00518
13.25	0.00286
15.25	0.00157
17.25	0.000855
19.25	0.000480
23.25	0.000195

Temp., °F.	K_3
−300	0.321
−290	0.341
−280	0.365
−270	0.385
−260	0.408
−250	0.429
−240	0.440
−220	0.494
−200	0.537
−180	0.580
−160	0.623
−140	0.661
−120	0.696
−100	0.750
− 80	0.793
− 60	0.834
− 40	0.876
− 20	0.921
0	0.964
20	1.005
40	1.050
60	1.090
80	1.130
100	1.175
120	1.215
140	1.255
160	1.313
180	1.340
200	1.385
220	1.425
240	1.470
260	1.505
280	1.550
300	1.592

Pressure, Psia.	K_4
1.0	7.71
2.0	3.86
3.0	2.58
4.0	1.930
5.0	1.542
6.0	1.288
7.0	1.105
8.0	0.966
9.0	0.858
10.0	0.771
11.0	0.705
12.0	0.644
13.0	0.594
14.0	0.552
14.7	0.526
15.0	0.515
16.0	0.483
17.0	0.455
18.0	0.430
19.0	0.406
20.0	0.386
22.0	0.352
24.0	0.321
26.0	0.298
28.0	0.276
30.0	0.258

Pressure, Psia.	K_4
32.0	0.242
34.0	0.227
36.0	0.215
38.0	0.202
40.0	0.1935
45	0.1720
50	0.1550
55	0.1405
60	0.1278
65	0.1190
70	0.1105
75	0.1030
80	0.0965
85	0.0909
90	0.0859
95	0.0819
100	0.0772
120	0.0644
140	0.0553
160	0.0483
180	0.0430
200	0.0386
225	0.0344
250	0.0308
275	0.0281
300	0.0258

TABLE II

Flow, Cu. Ft./Sec.	K_1
0.2	0.000252
0.3	0.000524
0.4	0.000885
0.5	0.00132
1.0	0.00417
1.5	0.00950
2.0	0.0160
2.5	0.0240
3.0	0.0330
3.5	0.0435
4.0	0.0550
5.0	0.0830
5.5	0.0970
6.0	0.1150
6.5	0.1330
7.0	0.1500
7.5	0.1710
8.0	0.1930
8.5	0.2150
9.0	0.2370
9.5	0.2670
10.0	0.2890
11.0	0.3410
12.0	0.400
13.0	0.460
14.0	0.526
15.0	0.595
16.0	0.670
17.0	0.746
18.0	0.837
19.0	0.912
20.0	1.00
22.5	1.256
25.0	1.495
27.5	1.775
30.0	2.075
32.5	2.40
35.0	2.74
37.5	2.96
40.0	3.60
42.5	4.03

Flow, Cu. Ft./Sec.	K_1
45.0	4.48
47.5	4.95
50.0	5.45
55.0	6.5
60.0	7.6
65.0	8.8
70.0	10.2
75.0	11.6
80.0	13.0
85.0	14.5
90.0	16.1
95.0	17.9
100	19.6
110	23.5
120	27.5
130	32
140	36.5
150	42
160	47
170	52
180	58
190	65
200	70
220	75
240	100
260	115
280	131
300	150
320	168
340	189
360	210
380	230
400	255
420	280
440	305
460	330
480	360
500	385
550	450
600	550
650	625

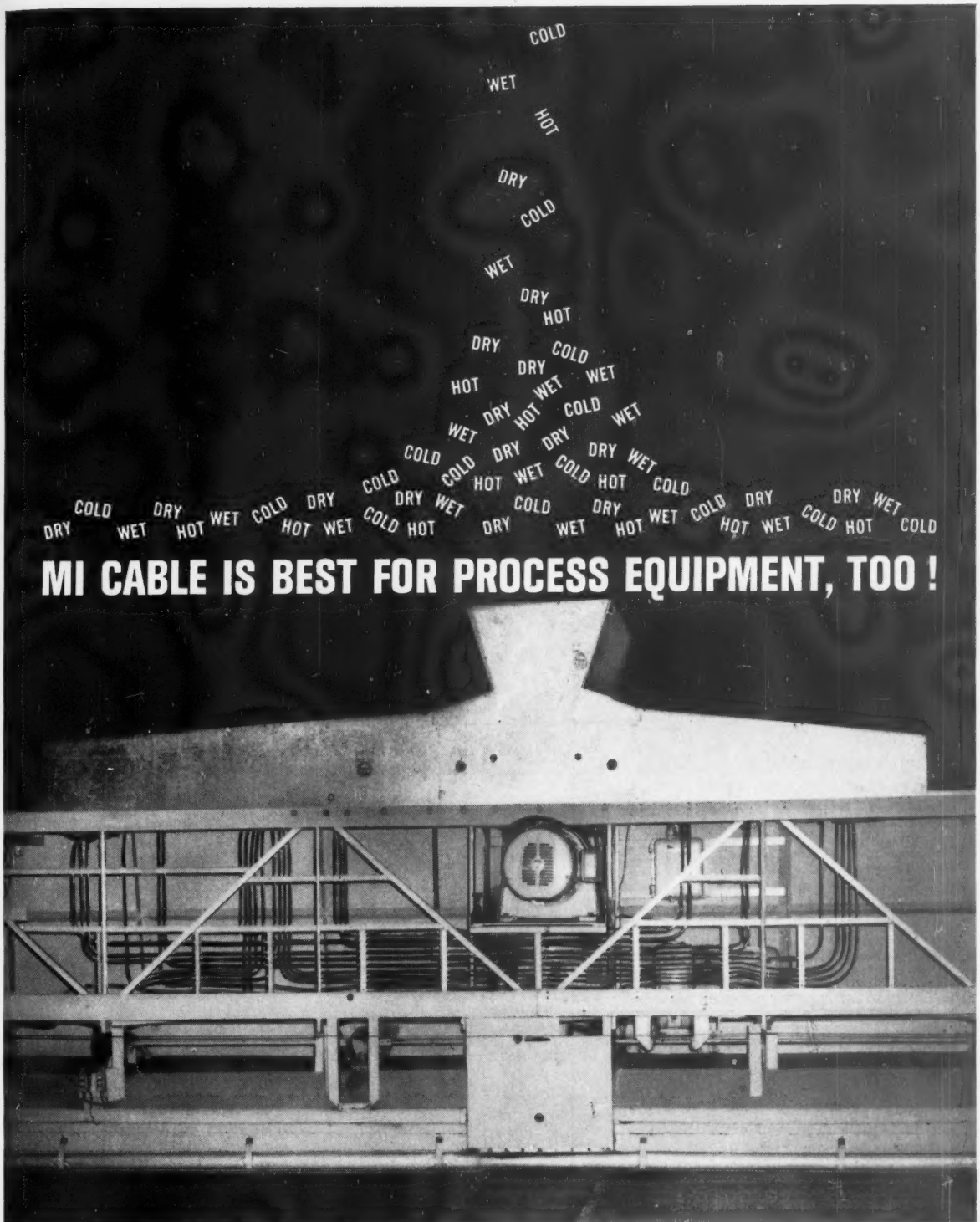
Flow, Cu. Ft./Sec.	K_1
700	720
750	810
800	915
850	1,030
900	1,150
950	1,260
1,000	1,380
1,100	1,650
1,200	1,950
1,300	2,370
1,400	2,590
1,500	2,930
1,600	3,280
1,700	3,740
1,800	4,140
1,900	4,560
2,000	5,000

Sp. G., Ref. to Air at S.T.P.	K_4
0.10	0.273
0.15	0.377
0.20	0.492
0.25	0.596
0.30	0.696
0.35	0.793
0.40	0.889
0.45	0.983
0.50	1.072
0.55	1.152
0.60	1.254
0.65	1.340
0.70	1.427
0.75	1.545
0.80	1.600
0.85	1.685
0.90	1.770
0.95	1.855
1.0	1.930
1.1	2.200

Sp. G., Ref. to Air at S.T.P.	K_4
1.2	2.260
1.3	2.410
1.4	2.570
1.5	2.720
1.6	2.89
1.7	2.93
1.8	3.18
1.9	3.34
2.0	3.49
2.2	3.78
2.4	4.07
2.6	4.35
2.8	4.62
3.0	4.92
3.5	5.62
4.0	6.20
4.5	6.93
5.0	7.13
6.0	8.89
7.0	10.10
8.0	11.3
9.0	12.5
10.0	13.7
15.0	19.3
20.0	24.5
30.0	34.7
40.0	44.5
50.0	54.5

Viscosity, Cp.	K_3
0.005	0.778
0.006	0.808
0.007	0.834
0.008	0.855
0.01	0.895
0.02	1.027
0.04	1.179
0.06	1.280
0.08	1.356
0.10	1.416

Note: For K_2, use values from Table I.



MI Cable in automatic kiln loader and unloader, one of many installations at Adolph Coors Co., Golden, Colo. Room Temperature varies from 40-200°F; humidity from 5-95%. ■ MI Cable is compact, easy to install, and approved for use by the NEC. It's available in 1, 2, 3, 4, 7/C—in all regular AWG sizes.

Mineral Insulated Cable is the most versatile and economical wiring you can use, for jobs up to 600 volts. Even under the worst conditions, it works beautifully. ■ In the MI Cable job shown here, for instance, in spite of temperatures to 200 F and humidity to 95%, there's been no trouble whatever in three years of continuous operation. ■ But get details on MI Cable and see for yourself how it might work for you. Write for Catalog S-2. General Cable Corporation, 730 Third Ave., New York 17, N.Y.

GCC
GENERAL CABLE CORPORATION

CE Cost File

No. 54: Packed-Tower Costs

Handy chart quickly and accurately gives cost of packing. This can be added to tower costs, available from a number of sources.

WILLIAM F. WROTH
Dow Chemical Co.
Freeport, Tex.

You can get a quick and accurate estimate of tower packing costs by using the chart at the right. These data, added to cost of a column, will result in total purchased cost for a packed tower.

There are many ways to obtain column costs. For rough estimating I use the following (6 to 24-in. dia., top blind flange, bottom bumped head, skirt, base ring):

Column purchased cost (without packing) = $18.5\ L_s f_m\ (D/12) + 57\ L_b\ (D/12)$.

D = Nominal tower dia., in.

L_s = Length of shell (bend line to flange), ft.

f_m = Material factor. (1.0 for steel. For stainless: 6-in. dia., 2.9; 12-in. dia., 3.25; 24-in. dia., 3.5).

L_b = Length of skirt, bottom of steel to bottom bend line, ft. (L_b = 0.2 L_s for L_s less than 50 ft., L_b = 10 for L_s greater than 50 ft.).

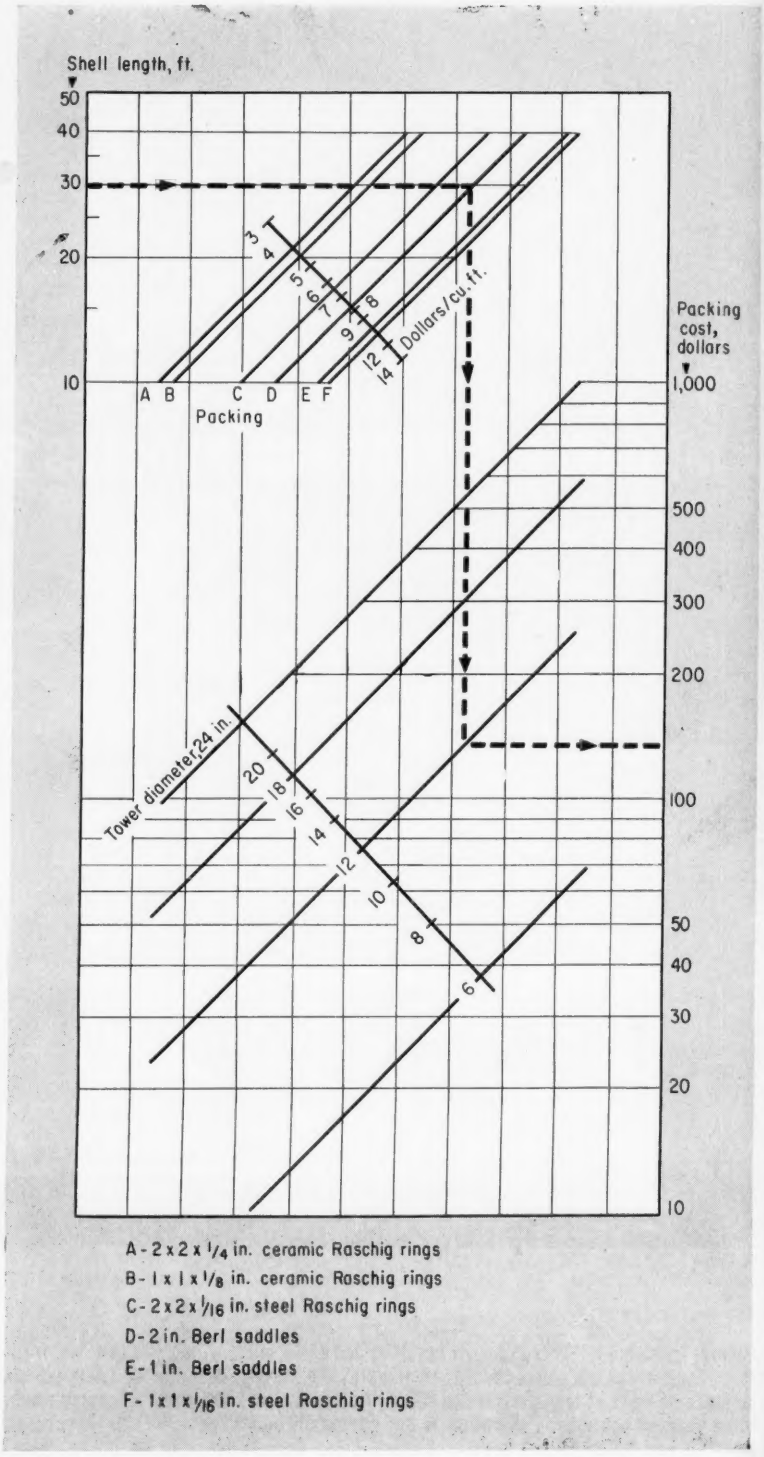
The chart presented here for various packings should be useful when comparing a number of alternate packings, or calculating packing costs for a large number of towers of different sizes.

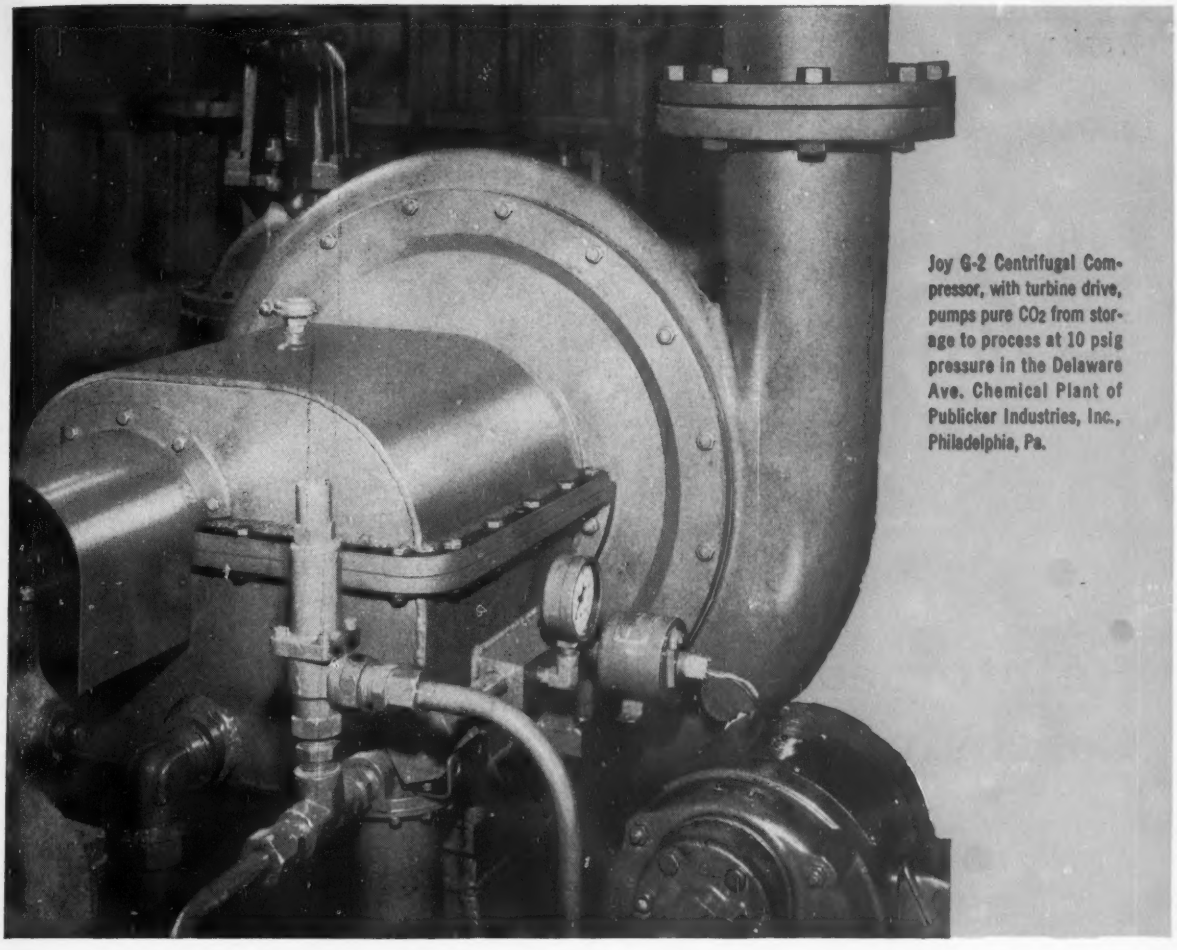
Charts are based on an approximation of packing height as follows:

Depth of packing = 0.744 × length of shell

In the example shown on the graph, the material cost of packing a 12-in. dia., 30-ft.-high tower with 2-in. Berl saddles is about $135. Uninstalled cost of a carbon-steel 12 x 30 tower would be $900.

Packing data are based on Sept. 1959 costs.





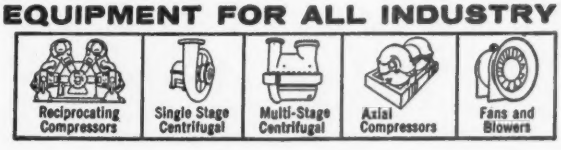
Joy G-2 Centrifugal Compressor, with turbine drive, pumps pure CO_2 from storage to process at 10 psig pressure in the Delaware Ave. Chemical Plant of Publicker Industries, Inc., Philadelphia, Pa.

Integral Gear Design of JOY Model G Centrifugal Compressors Saves Space—Gives Improved Reliability

The integral gear drive of Joy Model G Centrifugal Compressors, together with the highly efficient aerodynamic design, gives these machines twice the capacity of competitive units occupying the same floor space. High speed couplings are eliminated. Compressor and drive are mounted on a single base plate to further reduce the floor space requirement.

Joy Model G Centrifugals save you valuable floor space, and save you money by being "on the line" twenty-four hours a day—no costly process shutdowns. They are available in capacities from 500 to 15,000 cfm, for 4 to 20 psig duty on air service. Special seals and materials of construction can be provided to match any gas which you are handling. For full information on the Joy Model G Centrifugal, write for Bulletin 2564-11.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



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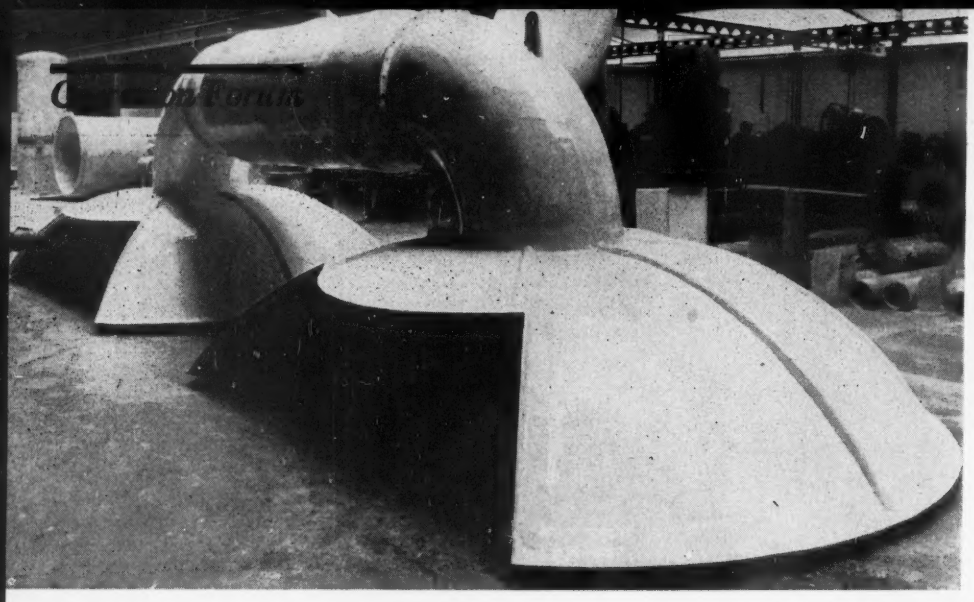


Fiber-glass-reinforced polyester ventilation system for twin process tanks. Exhaust vapors contain sulfuric acid and organic materials at 80-90 C.

A 36-in.-dia. × 70-ft.-high stack and axial fan of the same construction are a part of this system.

Reinforced Plastics for Corrosive Service—II

A guide to the design of chemical process equipment. The selection of resins and reinforcing materials for various services, including methods of testing and fabrication.

ROBERT M. WEBSTER*, *E. I. du Pont de Nemours & Co., Inc.*

There are four classes of plastics in common use for corrosion-resistant equipment: polyesters, epoxies, furans and phenolics. Polyesters have the widest current use.

To help in selecting materials, resin manufacturers and equipment fabricators have published information for general guidance. This data is usually given in qualitative terms, such as "excellent," "good," "poor," and "recommended" or "not recommended." Manufacturer's information usually covers a narrow range of variables established under ideal conditions in the laboratory. See p. 170 for this sort of information. More valuable data, however, have become available through quantitative as well as qualitative results of laboratory tests. One example is the current testing program by Atlas Powder Co. in which the corrosion resistance of various polyesters and epoxies are being compared (see *Chem. Eng.*, Apr. 3, p. 162, and June 12, p. 272).

Generally, the purchaser should not use manufacturers' information at face value, without first testing the material in a specific environment or in a reasonable laboratory duplication of this environment.

Checking the effect of total chemical environment on the mechanical behavior of the equipment is important also, because intermediate products in a process may affect the structure. Although a reinforced-plastic structure may adequately resist several different chemicals, separate tests do not prove conclusively that the laminate will tolerate these corrodents in combination, for their corrosive effects may be additive. Degradation resulting from exposure to a secondary environment—for example, sunlight—should also be determined where applicable. In addition, the possible use of chemicals other than those upon which equipment design was based must be considered.

Choosing candidate materials for the laminate can best be accomplished by consulting the resin manufacturers' and fabricators' guide charts. This step will eliminate the totally unsuitable resins. For example, phenolic resin will withstand relatively strong nonoxidizing acids at elevated temperatures, but it will not hold up generally with mild alkalis even at normal room temperatures. Furan resins, on the other hand, are dependable when used with most alkalis through a wide temperature range, and are also suitable with moderately strong nonoxidizing acids. From the list of suitable materials, the most resistant to the specific environment should be selected on the basis of experience and testing.

When polyester or epoxy resins are being considered, selection grows increasingly complex because each of these classes represents a family of materials. Each has members with greatly varying chemical and physical properties. For example, in the polyester family, bisphenol A polymers have shown the widest range of chemical resistance. Certain chlorinated polyester-sty-

*To Meet the Author, see *Chem. Eng.*, June 26, 1961, p. 158.

COMPARE

YOU'LL SEE WHY DURCO SLEEVELINE® VALVES ARE 5 WAYS BETTER

1.

LARGER SEALING AREA

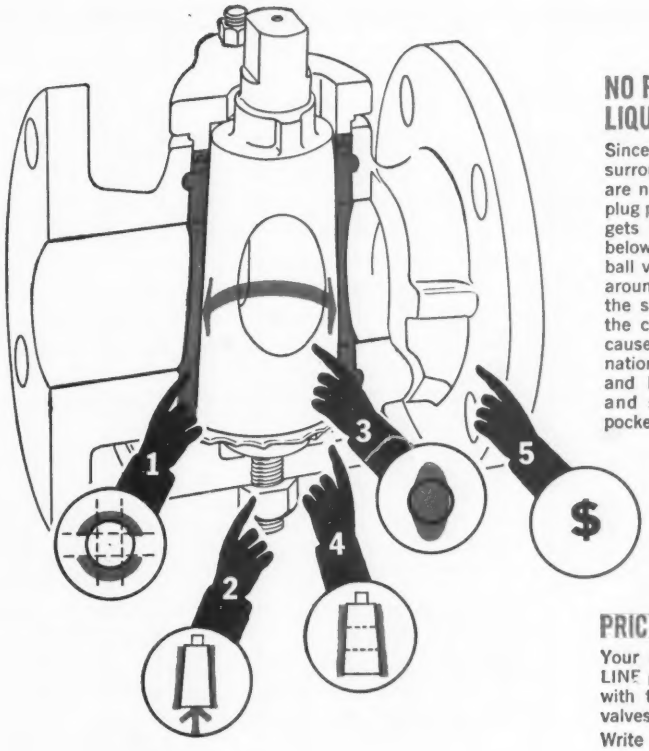
A continuous Teflon* sleeve surrounds the SLEEVELINE plug. This assures positive shut-off even after wear caused by slurries or hard-to-hold corrosive liquids. SLEEVELINE VALVES SEAL AFTER EVERY TURN. Ball valves have two seal rings with a minimum sealing area (almost line contact). Wear and erosion of the seals or roughness of the ball can quickly cause leak-through.

*Teflon is a du Pont Company registered trademark.

2.

BETTER ADJUSTMENT EXTENDS SERVICE LIFE

SLEEVELINE valves have up to ¼" vertical adjustment for seal wear, providing extended service life. Some ball valves have no adjustment for wear, while others require removal from the line or have limited adjustment.



4.

NO POCKET TO COLLECT LIQUIDS AND SOLIDS

Since the SLEEVELINE plug is surrounded by Teflon, there are no pockets into which the plug ports can drain. No Liquid gets to the body around or below the plug. The ports in ball valves drain into a pocket around the ball and between the seals when the ball is in the closed position. This can cause process fluid contamination; corrosion of the body and ball by stagnant liquid; and solids build-up in the pocket, creating seal failures.

5.

PRICE

Your comparison of SLEEVELINE prices and performances with those of other types of valves is also suggested.

Write for Durco Bulletin V/14

3.

LARGER AREA OF THE PORT OPENINGS

Nominal Pipe Size	Full Pipe Area in²	Typical Ball Valve area in²	Typical Ball Valve % Port opening	Durco area in²	Durco % Port Opening
½"	0.196	0.150	77	0.196	100
¾"	0.442	0.248	56	0.441	100
1"	0.785	0.518	66	0.785	100
1½"	1.767	1.227	69	1.150	65
2"	3.142	1.767	56	1.960	63
3"	7.068	4.430	63	3.800	54
4"	12.566	7.669	61	7.100	56
6"	28.274	15.465	55	17.000	60

Flow capacity is sometimes cited as a selling feature for ball valves. Compare some typical ball valve port openings with those of DURCO SLEEVELINE valves.

THE DURIRON COMPANY, INC., SERVES THE PROCESS INDUSTRIES FROM DAYTON, OHIO

DURCO

Corrosion resistance chart

(Use only as a guide for selection of coupons for field exposure testing.)

E = Excellent, G = Good, P = Poor, U = Unsatisfactory

	Polyester[1] Cold[4]	Polyester[1] Hot[5]	Polyester[2] Cold	Polyester[2] Hot	Epoxy[3] Cold	Epoxy[3] Hot	Furan Cold	Furan Hot	Phenolic Cold	Phenolic Hot
Inorganic acids										
Phosphoric acid, 10%	G	P	E	G	E	G	E	E	E	E
Hydrochloric acid, 30%	E	U	E	P	E	P	G	G	E	E
Sulfuric acid, 10%	E	G	E	G	E	G	E	E	E	E
Sulfuric acid, 40%	G	U	E	U	G	U	G	G	E	E
Sulfuric acid, 70%	U	U	U	U	P	U	P	U	E	E
Chromic acid, 10%	P	U	G	P	P	U	U	U	G	U
Nitric acid, 5%	G	U	G	P	P	U	U	U	P	U
Organic acids										
Benzoic acid, Sat.	E	G	E	E	E	G	E	E	E	E
Maleic acid, 25%	E	G	E	G	E	G	E	E	E	E
Oxalic acid, Sat.	G	P	E	G	G	P	E	E	E	E
Acetic acid, 10%	G	P	G	P	G	U	E	E	E	E
Alkalis										
Ammonium hydroxide, 10%	P	U	G	U	E	G	E	E	U	U
Potassium hydroxide, 10%	P	U	G	U	E	G	E	E	U	U
Sodium hydroxide, 10%	P	U	G	P	E	G	E	E	U	U
Sodium hydroxide, 30%	U	U	U	U	E	P	E	E	U	U
Sodium carbonate, 30%	G	P	E	G	E	E	E	E	P	U
Organic solvents										
Ethanol, 100%	G	P	G	P	E	P	G	P	G	P
Methanol, 100%	G	P	G	P	E	P	G	P	G	P
Ethylene glycol, 100%	E	E	E	E	E	G	E	E	E	G
Formaldehyde, 100%	P	U	G	U	G	P	G	P	G	P
Acetone, 100%	P		P		G		G		G	
Methyl ethyl ketone, 100%	U	U	U	U	G	P	G	P	G	P
Benzene, 100%	U	U	P	U	G	P	E	E	G	P
Toluene, 100%	U	U	U	U	E	P	E	G	G	P
o-Dichlorobenzene, 100%	U	U	U	U	G	P	E	G	G	P
Aniline, 100%	U	U	U	U	U	U	U	U	U	U
Salts										
Sodium chloride, 30%	E	G	E	E	E	G	E	E	E	E
Aluminum sulfate, 40%	G	P	E	G	E	E	E	E	E	E
Aluminum chloride, 40%	G	P	E	G	E	E	E	E	E	E
Ammonium sulfate, 40%	E	E	E	E	E	G	E	E	E	E
Ammonium chloride, 40%	E	G	E	E	E	E	E	E	E	E
Aniline hydrochloride, 30%	E	G	E	E	E	E	E	E	E	E
Aniline sulfate, 30%	G	P	E	E	E	E	E	E	E	E
Copper chloride, 30%	E	E	E	E	E	G	E	E	E	E
Copper sulfate, 30%	E	E	E	E	G	G	E	E	E	E
Oxidizing materials										
Chlorine dioxide	G	P	E	G	U	U	U	U	U	U
Hydrogen peroxide, 10%	G	P	E	G	U	U	U	U	U	U
Sodium hypochlorite, 10%	G	P	E	G	U	U	U	U	U	U

[1] Polyester, glycol, chemically resistant, hot-cured, general purpose. [2] polyester, bisphenol. [3] epoxy, metaphenylene diamine-cured. [4] ambient temperature. [5] 200 F. or 5 deg. F. below boiling point (where boiling point is below 200 F.)

rene polymers provide more fire resistance than other resins in the same family. Polyesters incorporating methyl methacrylate as the copolymer have increased transparency and resistance to ultraviolet rays or sunlight degradation. Differences in the behavior of polyesters become apparent from a study of the molecular structure of each type. Choice of an epoxy is even more complicated, because the chemical reistance and physical properties of the laminate are influenced even more radically by the type of curing agent utilized.

►**Reinforcing Materials**—Glass fiber is the most common reinforcing material used, because of its high temperature tolerance, good general resistance to chemical degradation, and outstanding strength characteristics (500 × 10^3 psi. tensile strength). Synthetic fibers may be substituted for glass in environments (e.g., hydrofluoric acid) that will attack the glass fiber. In such an application, synthetic fibers such as Dacron or Dynel are used to reinforce the surface exposed to the corrosive agents, and glass fiber is employed as the primary strength member of the laminate.

Reinforcing fibers are applied in two general forms: random mat and woven. Random mat is composed of 2-3 in. chopped fiber strands held together in sheet form by a soluble resin binder. Use of chemical-grade surfacing mat or veil is recommended for the exposed surface because it contributes to a high resin-to-glass ratio, the most suitable condition for chemical resistance. In addition, the random orientation and shortness of fibers in a mat produces a noncontinuous structure that limits wicking if a chemical penetrates the surface resin.

Woven reinforcing fabrics are generally used as the primary strength member of the laminate system. Fiber cloths are available in a number of types to allow proper fiber orientation in a specific application. For example, square- or plain-weave fabrics are used where uniform strength is required in two directions. Laminates fabricated of this type of material have superior impact strength since the crimp absorbs impact, but lower edgewise compression, flexural and tensile strength because the interlaced fibers tend to abrade one another.

A satin weave, where the warp and filling yarns go under one thread and over seven, is used where uniformity of strength is required in all directions. The limited interlacing minimizes crimp, and gives the laminate higher mechanical strength and a higher glass-to-resin ratio. Fabrics with a maximum of

warp and a minimum of filling yarns (e.g., unidirectional rovings) provide the highest directional strength values, in the direction of the warp, per unit thickness. This reinforcement may be limited to the directional load requirements.

▶**Other Laminate Ingredients** — Certain additives may be incorporated in the resin mix to provide the physical requirements for proper fabrication, and enhance the ultimate performance of the equipment. Inert fillers, such as silica flour, coke flour, and talc, are sometimes used in linings to decrease vapor absorption, improve impact resistance, reduce surface crazing, and lower exothermic heating during the curing process. These fillers can also be used to provide adjustment of the laminate expansion coefficient to agree with that of the substrate in applications where a temperature differential is caused by the operating environment. Another important additive is a thixotropic agent, used to prevent sagging of the uncured resin. Incorporation of a thixotropic agent is especially important for laying-up vertical surfaces.

Other specialized additives include antimony trioxide to increase fire resistance in chlorine-bearing resins, and special silicones to improve wetting properties of some resins. A polysulfide added to an epoxy system increases flexibility of the structure and enhances bonding to certain elastomeric materials.

▶**Testing the Resin System**—Before final selection of a resin system for a particular application can be made, the user should obtain data on the mechanical behavior of the composite laminate after exposure to the specific environment. Results of preliminary tests are usually based on appearance, loss or gain in weight, flexural strength characteristics, and surface hardness determination, after a 60-day exposure.

Unfortunately, loss or gain in weight may not reveal internal deterioration, a prime cause of premature failure in equipment. Inherent in the weighing test is the probability of compensating error and subsequent incorrect evaluation. For example, as the corrosive effects are taking place, the reinforced-plastic test coupon will usually absorb some of the test media. Thus, instead of showing a loss in weight indicative of the degree of destruction and erosion of the resin that has actually occurred, the coupon may weigh more because of the absorption of foreign materials.

Following the weighing at the end of the 60-day period, the sample should be exposed again, with two subsequent weighings at specified intervals. Comparison between three weighings will provide more positive indication of actual weight loss than a single weighing. Flexural strength determinations should be made at each interval on three samples of the material being considered. Plotting the three-time weighings and flexural test results and noting the slope of the curves will help the user predict long-range performance. For specific applications where compression or tensile strength is critical, three tests of these qualifications should also be made at predetermined intervals, and the results plotted for analysis.

▶**Structural Design**—Use of materials ideally suited for the specific environment is still not enough to assure long uninterrupted service life. Proper structural design, based on the mechanical properties of the specific laminate will also determine the success or failure of the equipment. The designer cannot merely transfer the design of a similar metal unit to one of reinforced plastic. Strengths, flexibilities and weights of reinforced plastics are different from those of metals, and the structure must be designed accordingly.

For example, thin flat sections of reinforced-plastic laminates must be designed with periodic upset curvatures to prevent sagging or bulging and resulting stress concentration. Angles at corner and edge sections should contain proper radii to achieve proper stress distribution. The stress problem is acute in reinforced-plastic equipment because corrosive deterioration is hastened as the stress increases. Branches set into the tank wall, and flanges bonded to a nozzle, should be reinforced with resin and fiber in the form of gussets for generous distribution of mechanical stresses. The joint should be at least as strong as the pieces being joined.

▶**Specifying**—After selecting the proper materials and working out the best structural design for the equipment, the user must depend upon the skill of the fabricator for serviceable equipment. The chemical processor should select a competent, reliable fabricator, with the choice based either on prior experience or adequate investigation. A number of such qualified fabricators are available.

In addition to the type of resin, additives and structural design data, specifications should include additional details, such as type of reinforcing fiber, fiber binder, fiber orientation, the sequence of lay-up, resin-to-glass ratio and dimensional tolerances. When different resins are used in a single laminate, the coefficient of expansion adjustment, flexibility, thickness of vapor and chemical barriers, and sequence of each material layer must be a part of the specification.

These specification details should not be left to the discretion of the fabricator. Experience over the past several years has caused Du Pont to develop rigorous specifications for its reinforced-plastic equipment. They include material specifications, strength and fabrication requirements, and provide for qualification of the fabricator. Resins have been limited to those approved through adequate testing. A description of materials required for assembling the equipment in the field is also supplied.

Fabrication techniques exert a vital influence on the integrity of the final product. Air inclusions weaken a laminate significantly. The type of catalyst system or curing agent helps determine the degree of chemical resistance, particularly in the epoxy resins. The inhibiting or accelerating effect of additives affects the rate and degree of cure, as well as the amount of exotherm. Excessive exothermic heat during curing of the resin will cause areas of high stress concentration. Therefore, the fabricator must maintain careful control of catalysts, promoters and accelerators.

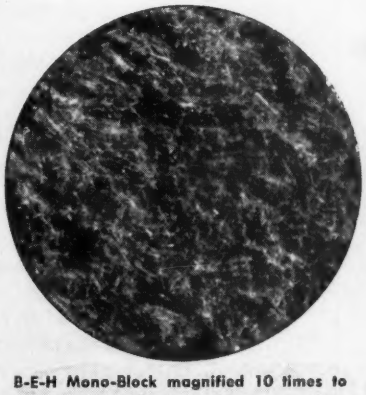
IT'S THE INTERLOCK THAT MAKES MONO-BLOCK®

It's no wonder that hundreds of industries' leaders specify Baldwin-Ehret-Hill Mono-Block for their medium and high temperature block insulation requirements, up to 1800 F.

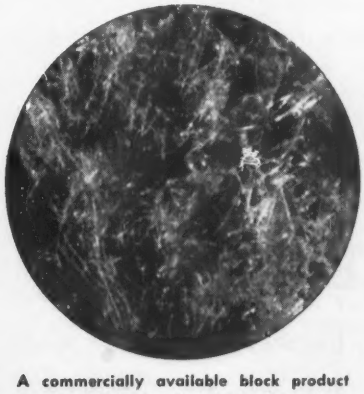
The reason? An exclusive Baldwin-Ehret-Hill manufacturing process assures that the fine mineral wool fibers used in Mono-Block are completely and thoroughly dispersed in a liquid slurry and thereby interlocked to provide the highest strength. Further, this interlocking process means that Mono-Block will cut cleanly and conform to irregular surfaces, such as lap or butt welds, etc., without tearing or breaking.

Another reason for Mono-Block's leadership is its high strength, minimizing loss due to breakage. And the tough, strong surface of Mono-Block can be directly finished with Baldwin-Ehret-Hill No. 1 or Super Powerhouse Cements in many instances without the need for applying wire mesh.

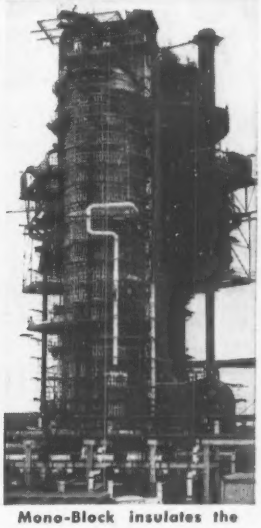
For detailed information about Mono-Block or any of the complete line of industrial insulations manufactured by Baldwin-Ehret-Hill, and the name of your nearby B-E-H qualified contractor, write to Department M-B, Baldwin-Ehret-Hill, Inc., 500 Breunig Ave., Trenton 2, N. J.



B-E-H Mono-Block magnified 10 times to show uniform, interlaced structure resulting from interlocked fibers.



A commercially available block product equally magnified to show the uneven texture.



Mono-Block insulates the world's largest catalytic cracking unit for Tidewater in Delaware.

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Baldwin-Ehret-Hill manufactures a complete line of mineral fiber, calcium silicate, 85% magnesia and polyurethane industrial insulation products, including pipe insulation, blocks, blankets, felts, cements and loose fill for sub-zero to 1900 F service.

BALDWIN-EHRET-HILL, INC.

Trenton **New Jersey**

CPI NEWS BRIEFS . . .

continued from page 78

Linde Co. has placed on stream at Pueblo, Colo., the 280-ton/day oxygen plant it has built, and will operate, for Colorado Fuel and Iron Co. Latter is currently spending $21 million at the site to expand its basic-oxygen steel facilities, due for startup "in the near future."

The Firestone Tire & Rubber Co. has completed a 20% expansion of its Pottstown, Pa., vinyl resin plant. Catalytic Construction Co. engineered and constructed the project, which boosts capacity both for the firm's Exon vinyls and for its byproduct paint latexes.

Foote Mineral Co. has placed its 100,000-lb./yr. butyl lithium plant on stream at New Johnsonville, Tenn. High-purity organolithium products include lithium metal dispersions, *n*-butyl lithium and *sec*-butyl lithium catalysts for the rubber, pharmaceutical and petrochemical industries.

International Minerals and Chemical Corp., Skokie, Ill., will invest $3.8 million to add diammonium phosphate to its line of nitrogenous fertilizer ingredients by Oct. 31, according to T. M. Ware, IMC president. Company plans a 100,000-ton/yr. plant at its Bonnie, Fla., phosphates complex to turn out the 18% nitrogen, 46% P_2O_5 product.

Dow Chemical Co.'s phenol sulfonic acid plant at Pittsburg, Calif., is now on stream (previously, Dow had shipped the chemical to West Coast customers from Midland, Mich.). The move steps up direct competition with Monsanto Chemical Co. for the estimated 3-million-lb./yr. western market. Monsanto has the advantage, since both its raw materials —phenol and sulfuric acid—are already available at its Avon, Calif., facilities; Dow has to ship them in.

Goliad Corp. has awarded O. L. Olsen Co. the construction contract for additional gas-processing facilities at Goliad's Wilcox plant

near Sheridan, Tex. Expansion program boosts throughput to 255 million cu. ft./day, and hikes (to an undisclosed figure) the amounts of ethane and propane recovered from the gas stream. Construction begins immediately; on-stream target date is October.

Weyerhaeuser Timber Co. schedules a 20% capacity increase at its Longview, Wash., paperboard mill by December. To cost an estimated $10 million, new facilities will include laboratories in which to develop new grades of bleached paperboard.

Texas Gas Corp. has "revamped and modernized" its Winnie, Tex., plant, which now produces 500 bbl./day of benzene concentrate from light gasoline fractions. Project cost $100,000, began turning out the petrochemical benzene to specifications within 48 hr. of startup.

Jersey Production Research Co. has begun constructing its $100,000 Earth Sciences Observatory near Leonard, Okla., about 20 miles southeast of Tulsa. An affiliate of Standard Oil Co. of New Jersey and Humble Oil and Refining Co., firm will carry out fundamental research in geophysics.

The Martin Co. has designed a line of air-transportable nuclear power plants to provide electricity and heat to outlying military installations. The first model was built and assembled in Martin's Baltimore, Md., factory, then taken apart and flown in 16 sections to Rapid City, S. D., for trucking the remaining distance to an isolated Air Force radar station near Sundance, Wyo. Designed to generate 1 mw. continuously for 20 years, unit will also deliver 7 million Btu./hr. of byproduct steam heat.

Du Pont has placed on stream at Victoria, Tex., a multimillion-lb./yr. high-pressure polyethylene plant. Till now, all of Du Pont's polyethylene—high- and low-pressure—was made at its Sabine River Works near Orange, Tex., the world's largest polyethylene com-

plex (350 million lb./yr.). The Victoria site is location of the firm's adiponitrile facility, on stream since 1950.

U. S. Industrial Chemicals Co. has placed an ethyl ether refining unit on stream at its Tuscola, Ill., petrochemical complex. Ethyl ether has been made at Tuscola for some time; till now, however, none of the 6-million-gal./yr. capacity had been refined (all was sold as Technical Refined Grade, which in effect is unrefined). New standards adopted by the American Chemical Society prompted the installation, which can refine "all the ether anyone wants to buy."

Offices

Putnam Chemical Co., a subsidiary of Badische Anilin- und Soda Fabrik AG., plans to relocate all company operations by Jan. 1, 1962, from its present headquarters in Beacon, N. Y., to Charlotte, N. C. Putnam makes dyestuffs, pigments, textile intermediates.

CompuDyne Corp., Hatboro, Pa., has opened a Los Angeles area office in Englewood, Calif., to service the aircraft, missile and chemicals industries.

The Duraloy Co., Scottdale, Pa., producers of static centrifugal and shell-molded high-alloy castings, has relocated its Detroit sales office from Pleasant Ridge to Troy, Mich.

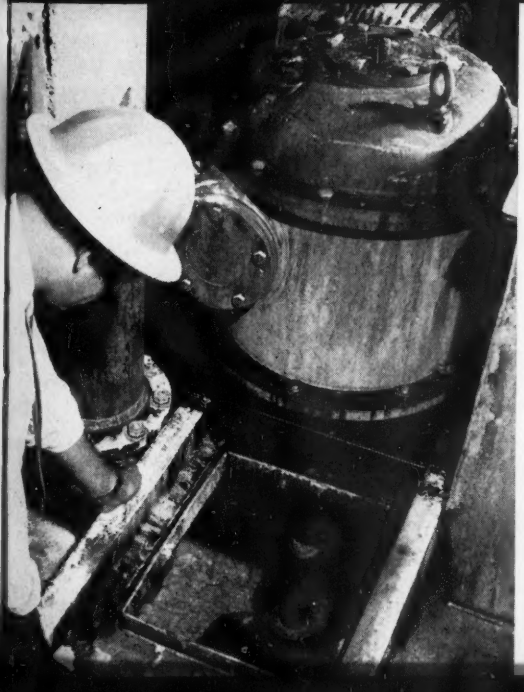
Fischer & Porter Co., a Warminster, Pa., manufacturer of instrumentation, laboratory and control hardware, has opened a New York sales office.

Companies

Standard Oil Co. of California has acquired **Standard Oil Co. of Kentucky,** subject to stockholder approval. Decree of consent from the U. S. Dept. of Justice has already been granted. Standard of Ken-

AT *tmc* . . . NINE YEARS OF COMPLETE MIXING WITH MINIMUM MAINTENANCE!

Improved Processing through Engineered Agitation



1 & 2. Drives of rugged Nettco mixers in Acid Mixing Room are periodically inspected—require minimum maintenance.

3. A complete mix is the result of Nettco Engineered Agitation in large tanks of hot phosphate solutions.

4. Soda ash dissolving in hot water . . one of many Nettco mixing applications at FMC.

13 Nettco Mixers in Constant Service—and only two bearing replacements in *nine years*. This is NETTCO's performance record at the Newark, California plant of the Mineral Products Division of Food Machinery and Chemical Corporation.

Downtime Can Be Expensive—a breakdown can tie up an entire production line. In FMC production lines—atop large tanks of boiling liquids . . . subject to extremely heavy starting loads—operating in high humidity atmospheres—durable NETTCO mixers provide consistently balanced mixes with minimum maintenance.

At FMC, Nettco Mixers are used for: agitating, mixing, reacting, suspending solids, blending miscible liquids, circulating, heat transfer and continuous treating. The results: Complete mixes, close product control and minimum downtime.

For Dependable Mixing—more profit in your process—contact your nearest Nettco representative. See Chemical Engineering Catalog or Refinery Catalog for address . . . or write for Bulletin 581.

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NETTCO
ENGINEERED AGITATION SPECIALISTS
EVERETT 49, MASSACHUSETTS

tucky shareholders will get one share of Standard of California's new cumulative, voting, convertible preferred stock for each common share they now hold.

FMC Corp. is the new name of Food Machinery and Chemical Corp. J. M. Hait, FMC president, notes that the physical changeover will in fact take place gradually, so that the firm will probably not be "fully in business" with its new name until the first of next year.

Air Reduction Co., New York, is about to acquire **Speer Carbon Co.**, St. Marys, Pa. Directors of both firms have approved; stockholders have yet to vote. Speer Carbon sold $25 million of carbon and graphite products in 1960, compared with Air Reduction's $202 million in liquefaction hardware, industrial gases, welding and cutting equipment. Terms of the acquisition: one share of Air Reduction for 2.25 of Speer Carbon.

Textron Inc., Providence, R. I., has purchased **Spencer Kellogg and Sons, Inc.**, Buffalo, N. Y., by exchanging 1,250,000 Textron common shares for 1,071,429 of Kellogg's. Textron currently has annual sales of about $450 million; Kellogg sold $116 million in 1960.

Nopco Chemical Co., Newark, N. J., has acquired six Midwestern urethane foam producers from the D & W Clark Corp., a privately held Chicago firm, for 30,000 shares of common stock. The six new Nopco subsidiaries: Clark Foam Products Co. (Ill.), Clark Products, Inc. (Ind.), Clark Products, Inc. (Neb.), Clark Foam Rubber & Fabrics, Inc. (Colo.), Clark Foam Rubber, Inc. (Minn.), and Clark Fibre Products, Inc. (Ill.). Combined 1960 sales of the six companies were $5.8 million; Nopco sold $39.8 million.

Humble Pipe Line Co., a wholly owned subsidiary of Humble Oil & Refining Co., wants to acquire **Interstate Oil Pipe Line Co.**, a wholly owned subsidiary of Standard Oil Co. of New Jersey. Inter-

state daily pumps 470,000 bbl. of crude oil and petrochemicals through 3,000 miles of pipeline in Louisiana, Mississippi, Illinois and Montana; Humble sends 600,000 bbl./day through 9,500 miles of Texas line.

Pearsall Chemical Corp. is the new name of Chemtron Corp., Phillipsburg, N. J. The firm makes aluminum, zinc and ferric chlorides, copper sulfate and chlorinated paraffin waxes in Brainards, N. J.; Sarnia, Ont.; and LaPorte, Tex. President M. Pearsall, noting that "it seemed wise to adopt a new name that would not be confused with other names in the chemical field," was clearly thinking of Chemtron's huge but indirect competitor, Chemetron Corp.

International

Canada: Atomic Energy of Canada, Ltd., has created a 31,500-sq. ft. artificial lake-bed, lined with polyethylene film to hold a million gallons of radioactively polluted water at Chalk River, Ont., the country's nuclear energy center. Basin is an emergency stopgap, designed temporarily to store any fuel-rod cooling water that suddenly contaminates when a reactor breaks down. (Radioactivity would later be cleaned, and water dumped in the Chalk River.) Mastex Industries, Ltd., Brampton, Ont., provided and laid the taped-together polyethylene sheets.

West Germany: Wintershall A.G. plans a $2-million gas-processing plant in the recently discovered natural gas fields near Dueste, a small town southwest of Bremen. The Fluor Corp. Ltd.'s new bulk-removal sweetening process will get its first overseas tryout at the installation, treating 28 million std. cu. ft./day at 1,000 psi.

Japan: Bridgestone Tire Co., Ltd., Tokyo, has licensed Phillips Petroleum Co.'s *cis*-polybutadiene process, plans a 10,000-ton/yr. plant to make the new type of syn-

thetic rubber. Site has not yet been picked. (Phillips commercialized the polymer just last year at Borger, Tex., is selling it to heavy-duty-tire makers in the States under the trademark Cis-4.)

Canada: Polymer Corp., Ltd., has awarded The Fluor Corp. of Canada, Ltd., a $1.5-million contract to engineer and construct a butadiene extractor at Sarnia, Ont. Unit will be first in the hemisphere to use Shell Development Co.'s acetonitrile extractive - distillation process, a new route to high-purity product. Plant comes on stream in the fall.

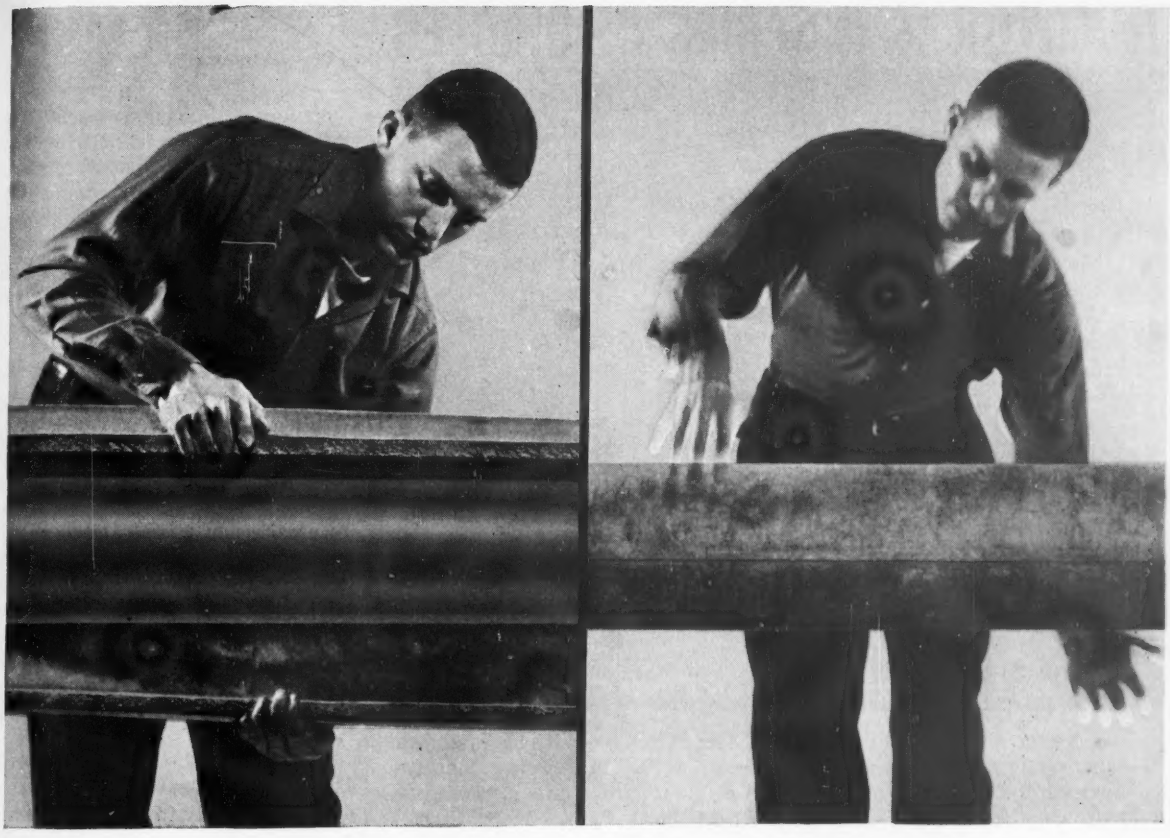
West Germany: Electrochemische Werke Muenchen AG., Hoellriegelskreuth, West Germany, has been bought by Laporte Industries Ltd., London, England, for $4.2 million. The German firm is a major producer of electrolytic hydrogen peroxide, inorganic peroxides, persulfate and chlorides—and, in fact, some time ago licensed its routes to one of Laporte Industries' chief British subsidiaries, Laporte Chemicals Ltd.

Canada: Cooperative Refineries, Regina, Sask., has begun a three-year, $1.3-million expansion of its Regina refinery. Crude oil throughput will be hiked 40% to 22.500 bbl./day.

United Arab Republic has set up a new state-held chemicals company—El-Nasr Petroleum Industrialization and Petrochemicals Co., capitalized at $84 million—to own and operate the gigantic petrochemicals complex planned for Suez (*Chem. Eng.*, May 15, p. 202). All 7.5 million shares of the new firm are owned by UAR's Economic Development Organization.

Canada: British American Oil Co., Ltd., has placed on stream its $2.5-million Udex aromatics unit at Montreal East. Capacity of 6 million gal./yr. is slated for captive processing into cumene.

Iraq's Economic Planning Board has mapped a pulp-and-paper mill for Basrah, in the reedy marshland



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of southern Iraq. Due on stream in 1964, facility would turn out 40,000 tons/yr. of paper, cardboard and other paper products, originally from reeds and imported kraft pulp, but eventually from domestic kraft pulp alone (for which a crop of eucalyptus trees are now being planted).

People

R. Norris Shreve, author of the definitive text, "Chemical Process Industries," was awarded an honorary Doctorate of Engineering by **Purdue University** at its June 4 commencement exercises. Shreve taught at Purdue from 1930 to 1947, from which time until 1951 he was dean of Purdue's School of Chemical and Metallurgical Engineering.

A *summa cum laude* Harvard graduate in chemistry, Shreve is well known for his consulting work on unit processes, his full or part authorship of ten books and over a hundred papers, and his Purdue-backed role in creating a university of 4,000 engineering students on the island of Formosa. Shreve belongs to a host of professional and honorary societies, among them AIChE, ACS, Alpha Chi Sigma, Phi Beta Kappa and Tau Beta Pi.

Alfredo F. Bracht has been elected president of **Petroquimica Argentina S.A.** (PASA), the $70-million Argentine petrochemicals firm created recently by Continental Oil Co., U. S. Rubber Co., Cities Service Oil Co., Fish International Corp., and Witco Chemical Co. At the same time, **Wesley S. Coe** was elected PASA's managing director for the sprawling, nine-plant complex now on the drawing boards for San Lorenzo, near Buenos Aires. Coe is former director of research and development for Naugatuck Chemical Div. of U. S. Rubber.

Howard S. Bunn, vice chairman of the board of Union Carbide Corp., has been elected chairman

of the board of directors of the **Manufacturing Chemists' Assn.** Also elected at the association's 89th annual meeting was **Robert B. Semple,** president of Wyandotte Chemicals Corp., to serve as chairman of the executive committee.

William C. Foster, newly appointed president of **United Nuclear Corp.,** has announced the election of **Alexander Keyes** as the corporation's secretary; **Edward Savage, Jr.,** as general counsel and director of administration; and **Robert D. Tegtmeier** as treasurer and controller. United Nuclear was created June 1 by combining Olin Mathieson's Nuclear Fuels Operation, the Nuclear Development Corp. of America, and Mallinckrodt Chemical Works' Commercial Nuclear Operations.

Robert W. Garrett has been appointed assistant to the president of **California Chemical Co.'s Ortho Div.,** capping 24 years with California Chemical and its parent, Standard Oil Co. of California. Since 1955, Garrett had been chief analyst for Ortho.

Henry C. Wohlers has been appointed director of technical services for San Francisco's **Bay Area Air Pollution Control District.** Wohlers studied at the University of Munich in West Germany, took his Ph.D. in physical chemistry from Stanford University in 1949. His professional realm of interest has centered on the effects of waste gases, artificial hormones and inorganics on plant life, through research and plant projects at General Chemical Co., Dorr Co., and Stanford Research Institute.

Gilbert I. Addis has been appointed assistant director of vinyl planning for **Union Carbide Plastics Co.'s** development department. In his new position, Addis will coordinate the company's development of all Bakelite vinyls. He won a Ph.D. in chemical engineering from Johns Hopkins University in 1942, after undergraduate work in mechanical engineering at Stevens Institute of Technology.

Convention Calendar

July

17-21. National Assn. of Power Engineers, National Convention, Sheraton-Gibson Hotel, Cincinnati, Ohio.

17-21. Gordon Research Conference, Organic Coatings, Kimball Union Academy, Meriden, N. H.

18-20. Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, Calif.

24-28. Gordon Research Conferences, Corrosion-Oxidation of Metal Surfaces, Colby Junior College, New London, N. H.

31-11. Case Institute of Technology, Digital Control Systems Course, Cleveland, Ohio.

August

3-5. Chemical Institute of Canada, Annual Conference and Exhibition, Queen Elizabeth Hotel, Montreal, Que.

7-11. Gordon Research Conferences, Separation and Purification, Colby Junior College, New London, N. H.

7-11. Gordon Research Conference, Statistics in Chemistry and Chemical Engineering, New Hampton School, New Hampton, N. H.

14-17. Louisiana State University, Ninth Annual Short Course in Fundamentals of Occupational Safety, Baton Rouge, La.

14-18. Gordon Research Conference, Instrumentation, Colby Junior College, New London, N. H.

15-17. University of Michigan, Cryogenic Engineering Conference, Ann Arbor, Mich.

15-18. Technical Assn. of the Pulp and Paper Industry, Testing Conference, Queen Elizabeth Hotel, Montreal, Que.

21-31. United Nations Conference on New Sources of Energy, Ciro Massino, Rome, Italy.

21-1. Wayne State University, International Conference on Coordination Chemistry, Detroit, Mich.

22-25. Western Electronics Show and Conference, Cow Palace Hotel, San Francisco, Calif.

28-31. Mathematical Assn. of America, Summer Meeting, Oklahoma State University, Stillwater, Okla.

28-1. American Society of Mechanical Engineers, International Conference on Heat Transfer, University of Colorado, Boulder, Colo.

September

3-8. American Chemical Society, National Meeting, Chicago, Ill.

6-8. Assn. for Computing Machinery, Annual Meeting, Statler-Hilton Hotel, Los Angeles, Calif.

6-8. Massachusetts Institute of Technology, International Symposium on Transmission and Processing of Information, Cambridge, Mass.

11-15. Instrument Society of America, 16th Annual Instrument-Automation Conference & Exhibit, Biltmore Hotel and Memorial Sports Arena, Los Angeles, Calif.

11-15. National Industrial Conference Board, Stanford Research Institute, International Industrial Conference, Fairmont Hotel, San Francisco, Calif.

12-15. Pennsylvania State University, Seminar for Manufacturing Engineers, University Park, Penna.

14-15. American Society of Mechanical Engineers, American Institute of Electrical Engineers, Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

17-22. Pennsylvania State University, Work Measurement Course, University Park, Penna.

18-20. Canadian Agricultural Chemicals Assn., 9th Annual Meeting and Conference, Mont Tremblant Lodge, Mont Tremblant, Que., Canada.

18-20. Standards Engineers Society, Annual Meeting, Hotel Sherman, Chicago, Ill.

22-1. 1st International Plastics Fair of Denmark, Forum, Copenhagen, Denmark.

24-27. American Institute of Chemical Engineers, National Meeting, Lake Placid, N. Y.

24-27. American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City, Mo.

25-28. Industrial Building Exposition & Congress, New York Coliseum, New York, N. Y.

Later

October 11-12. CHEMICAL ENGINEERING and Armour Research Foundation, Conference on the New Trends in Chemistry, Sheraton Towers Hotel, Chicago, Ill.

November 27-December 1. 28th Exposition of the Chemical Industries, New York Coliseum, New York, N. Y.

NEW EQUIPMENT . . .

continued from page 90

1,800, 1,500, 1,200, 900 and 750 rpm. — **Westinghouse Electric Corp., Hyde Park, Mass.** 90D

Needle valve

Soft-seat feature assures tight sealing up to 6,000 psi. at 150 F.

Model 816 valve is intended for general service with liquids, and gases (including helium) up to 6,000 psi. at 150 F. By using Teflon O-rings, temperature range is widened, from −330 to +500 F.

Featuring a handle that protects bonnet and stem from foreign particles, the valve is available in Types 303 and 316 stainless steels, aluminum alloys and other materials. It is threaded for ⅛, ¼ and ⅜-in. pipe. Types AND 10050 and 10050-6 tube porting connectors are available, other port connections can be obtained upon request.— **Dragon Engineering Co., Norwalk, Calif.** 186A

Evaporator-stripper

Unit recovers up to 99% of solvent without use of stripping steam.

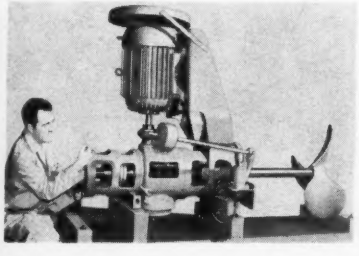
Solvent is continuously recovered from nonvolatile contaminants at a rate of 5 to 1,000 gph. with an evaporator-stripper that is compact and easy to operate.

Consisting of a vertical tube-type evaporator and a stripping

column of the tube-and-disk type, the unit has low pressure drop with efficiency about the same as a packed tower. Recoveries of 99% can be obtained without stripping steam; with it, the recovery may be as high as 99.9%.

Contaminated solvent is fed to a steam-heated evaporator where 80-90% of the solvent evaporates in a single pass. Vapor is separated, liquid passes on to a jacketed tube-and-disk stripping column where the remaining contaminants are removed. Vapor is condensed to obtain solvent product.

Cost of recovery is said to be less than 1¢/gal. for reclaiming chlorinated hydrocarbons, and in processing of plasticizers, glycerin, fatty acids, heat-sensitive materials, greases and polymers. **—Artisan Metal Products, Inc., Waltham, Mass. 186B**



Side-entering mixer

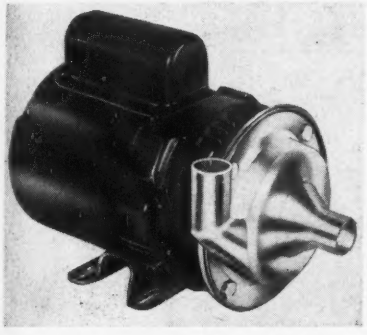
Higher capacity claimed for unit that also costs less to operate.

Innovations in design of side-entering mixers have produced a unit that offers greater capacity with less initial investment, according to the manufacturer.

Called Lightnin NSE, the mixer incorporates right-angle spiral bevel gears with hollow quill speed reducers to increase shock-load protection. A newly designed propeller offers improved hydraulic efficiency that permits installation of higher-rated low-speed mixers through conventional-size manways.

Three sizes are available for the horsepower range from 1 to 50. One 50-hp. unit will do the work that formerly required three 25-

hp. units, thus the number of multiple-unit installations is reduced. Series RSE mixers (1-25 hp.) are available for applications not requiring special shock-load protection.—**Mixing Equipment Co., Rochester, N. Y.** 187A



Centrifugal pump

Pressurized double seals make it suitable for corrosive service.

Designed to handle extremely corrosive chemical slurries, this centrifugal pump has built-in double seals. A pressurized system provides clean liquid for the seals without external pumps or liquid connections.

Constructed of Type 316 stainless, Monel, Hastelloy, tantalum or special alloys, the pump is available in single- or double-stage construction, may be used as a portable unit. Seals may be replaced without disturbing the discharge piping or motor coupling.

Capacity is 10 gpm. at 100 ft. head, increases to 90 gpm. at 10 ft. head.—**Instronics Div. of Jani Inc., Chicago.** 189A

Microfilter

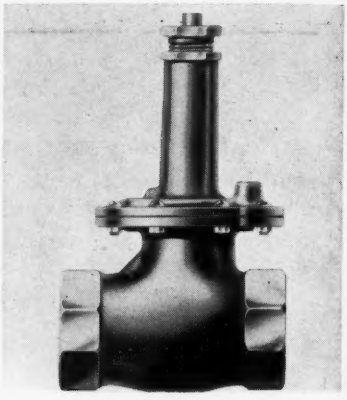
Offset port raises capacity by 25%, prolongs element life.

Operating at pressures to 10,000 psi., a newly designed microfilter for removing particles as small as 2 microns has greater capacity and lower pressure drop than standard units.

The changed design increases size of the inlet port and reduces

the angle that the entering fluid must negotiate to get into the filter element. The offset outlet port is maintained at same size as in standard filter designs.

With the outlet port offset, the top flange of the element can be designed as a splash plate, which disperses the fluid more evenly around the element and prevents local overloading. Capacity gain is up to 25% in average-size units, greater in large units. Filter removes particles from 100 down to 2 microns as desired.—**Fluid Dynamics Inc., New York.** **189B**



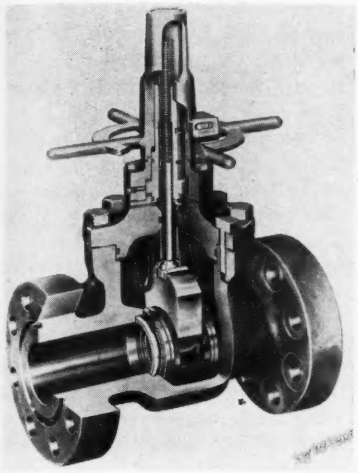
Shutoff valve

Valve closes automatically on an increase in pressure, temperature.

The IP-L/TEMP series of valves incorporates a diaphragm that senses line pressure, and closes the valve when pressure exceeds a predetermined level. In addition, a fusible plug with a preset temperature rating is activated when the critical thermal point is reached.

The valves are available in ASA pressure ratings from 150 to 2,500 psi., with higher pressures on request. Connections include screw, flange or weld, in sizes from ½ through 12 in. Larger sizes are also available.

Also offered is another model, the DP-L/TEMP, designed to close automatically on decreasing pressure. Temperature actuation is the same.—**Security Valve Co., So. Pasadena, Calif.** **190A**

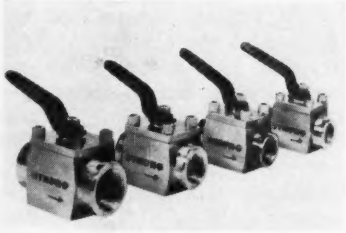


Plastic-coated gate valve

Abrasion- and corrosion-resistant unit handles liquid and slurries.

A chrome-plated steel gate, and plastic coating on internal valve surfaces, keep corrosion low in process piping situations where cement, chemicals and other abrasive-corrosive liquids and slurries are handled at temperatures up to 250 F.

Valve wear is largely confined to the replaceable gate and an insert ring made of synthetic rubber and steel. The unit is available with screwed ends in 2, 3 and 4-in. sizes for pressures of 2,000 or 3,000 psi. Flanged-end valves serve for pressures of 1,440 and 2,160 psi.—**Edward Valves, Inc., subsidiary of Rockwell Mfg. Co., E. Chicago, Ind.** **191A**



Ball valve

Top-entry unit, made from bar stock, has large flow passage.

A top-entry ball valve features a one-piece body constructed from

either cadmium-plated carbon steel or stainless steel bar stock. It is designed for on-off valving of gas, air, oil, water and with liquid chemicals.

Operating range is 150 psi., at 365 F., for steam lines, and 1,000 psi. for other applications. A chrome-plated bronze or stainless steel ball rests between seals of buna-N rubber or Teflon. Flow passage is precision-drilled through the ball to give optimum flow.

A large orifice area through the valve, particularly in smaller sizes, is said to give more flow with less noise and pressure drop than do many of the other valves of the same size.

Mounted parallel to the flow passage, the handle indicates the direction of the opening. Available in ½ to 1-in. sizes, valve can be serviced by removing four screws, without disturbing its position in the line.—**Strong, Conneaut, Ohio.** 191B

Water chiller requires less than 8 sq. ft. of floor space, has either capillary refrigerant feeding system or thermal expansion valve. Models deliver 17 or 25 tons of refrigeration at 105-F. condenser temperature and 40-F. suction.—**Typhoon Heat Pump Div., Hupp Corp., Tampa, Fla.** 192A

Additive meter for dry, granular materials has a chamber for carrying the additive, with a tube extending through the diameter. An opening in the tube picks up the material, which is then dumped as the chamber revolves. The size of the opening, and chamber rpm. determine rate of addition.—**Tropic Tone Mfg. Co., No. Tonawanda, N. Y.** 192B

Thermoelectric generator burns natural gas, propane or butane. Output is 8 w. for powering remote, unattended field instrumentation. The 65-lb. unit needs no housing, since burner is free from wind blowout. Other output ranges are available.—**Texas Instruments Inc., Houston.** 192C

External vibrator comes in three sizes, has impact range from 500 to 1,400 lb. for bins, chutes and railroad cars. Totally enclosed, with adjustable eccentrics, the electric units have a power to weight ratio of at least 20 to 1.—**Tremix Co., Inc., Binghamton, N. Y.** 193A

Flareless tube coupling has symmetrical ferrule with large contact area to dampen vibration and prevent stress concentration. Ferrule's biting edges groove the tube lightly at two locations, cause the ferrule to become an integral part of the tube even after frequent assembly and disassembly.—**AFCO Fitting Co., Div. of The U. S. Air Compressor Co., Cleveland.** 193B

Ball valve has secondary metallic seating surface that provides tight shutoff against flammable or dangerous fluids in the event of a fire that might elevate temperatures beyond the limits of standard nonmetallic seating materials, such as Teflon. — **Hills-McCanna Co., Carpentersville, Ill.** 193C

Equipment Cost Indexes . . .

	Dec. 1960	Mar. 1961
Industry		
Avg. of all	237.3	237.2
Process Industries		
Cement mfg.	231.6	231.3
Chemical	238.1	238.0
Clay products	225.1	224.8
Glass mfg.	224.8	224.7
Paint mfg.	229.4	229.7
Paper mfg.	229.4	229.3
Petroleum ind.	234.3	234.7
Rubber ind.	237.1	237.6
Process ind. avg.	236.1	235.9
Related Industries		
Elec. Power equip.	238.3	237.9
Mining, milling	239.5	239.4
Refrigerating	268.0	268.5
Steam power	224.5	224.9

Compiled quarterly by Marshall and Stevens, Los Angeles, for 47 different industries. See Chem. Eng., No. 1947, pp. 124-6, for method of obtaining index numbers; Mar. 6, 1961, pp. 115-116, for annual averages since 1913.

Technical Bookshelf

WATER

The technological revolution in water, especially in the marine environment, is a startling development scarcely foreseen a decade ago. But now the boom is on, and the race to inner space may prove to be as concentrated an effort as has been the flight to the heights. Technical Bookshelf measures the current flow of water literature, lists material in various areas of interest to CE readers.—HSG

WATER—THE MIRROR OF SCIENCE. By K. S. Davis and J. A. Day. Doubleday Anchor (paperback, original). 195 pages. 95¢. An introduction to the study of water as a substance. Aimed at the general reader, the work nonetheless has much to offer any technician not daily immersed in the subject. Water's chemistry is well-detailed, particularly its "unusual properties." A history of water research is included, while a final chapter, "The Waters of Life," discusses formation of animate matter.

THE MARINE CORROSION HANDBOOK. By T. H. Rogers. McGraw-Hill. 297 pages. $12.50. Filling a huge gap in the literature, this volume surveys the field expertly, is made more interesting by the many personal advices offered on a wide range of problems. Subjects, handled alphabetically, include: cavitation, corrosion fatigue, fouling, impingement attack, mechanical descaling, rust. Among the metals and alloys considered: beryllium, cadmium, cobalt, molybdenum. There is a particularly detailed section on aluminum.

SALINE WATER CONVERSION. American Chemical Society, Washington, D. C. 246 pages. $5.85. A collection of papers presented at the 137th national meeting of the ACS, Cleveland, April 1960. Although

this collection of talks does not by any means cover all the recent developments in the field, it does give an indication of the wide range of research that private industry, the universities and the government are putting into this problem. Twenty-two papers are presented, running the gamut from corrosion research to energy computations for many of the conversion processes now under investigation.

SALINE WATER CONVERSION REPORT FOR 1960. U. S. Dept. of Interior. 135 pages. Free. Report is the latest that the Office of Saline Water annually submits to the President, summarizing its water desalting activities of the previous year. Volume has three sections, corresponding to the areas of the Office's work: fundamental research, process development, demonstration. Each includes nontechnical but informative descriptions of the various projects under study, which deal not only with desalting but also with allied fields such as corrosion and the use of radioisotopes as a heat source. Book makes liberal use of photos, diagrams, graphs and tables, but some of the graphs are on a much higher technical plane than the text they accompany. Especially interesting is the demonstration section on the semicommercial-scale plants in the government program.

MANUAL ON INDUSTRIAL WATER AND INDUSTRIAL WASTE WATER. STP 148-E. 2nd ed. 2nd printing. American Society for Testing Materials, Philadelphia. 674 pages. $11. This standard volume for those concerned with water supply and treatment contains all 84 ASTM methods for the examination of water. The first part of the book presents a general discussion of industrial water supply and treatment and, as new material, a similar discussion on the handling of industrial wastes. The second printing includes two testing procedures not in the first.

WASTE DISPOSAL IN THE MARINE ENVIRONMENT. Ed. by E. A. Pearson. Pergamon. 569 pages. $12.50. Contained in this volume are all

papers presented at the first international conference on the title subject, in July 1959, at Berkeley, Calif. While much attention is paid to effects of pollution on marine life, engineers will gain valuable information from articles on waste-treating design, including N. H. Brooks' interesting discussion "Diffusion of Sewage Effluent in an Ocean Current" and R. D. Pomeroy's "The Empirical Approach for Determining the Required Length of the Ocean Outfall."

WASTE TREATMENT. Ed. by P. C. G. Isaac. Pergamon. 477 pages. $15. This volume contains the papers presented at an international symposium held in Newcastle, England, in Sept. 1959. The symposium covered two aspects of waste treatment—theory and practice of biological treatment and the disposal of solids removed from liquid wastes. The book will be of primary interest to sanitary engineers because most of the papers deal with sewage treatment. There are, however, a few papers on industrial-waste treatment—one on chemical wastes in general, and others on wastes from distilleries, tanneries, food-processing plants, etc.

SYMPOSIUM ON TECHNICAL DEVELOPMENTS IN THE HANDLING AND UTILIZATION OF WATER AND INDUSTRIAL WASTE WATER. STP 273. American Society for Testing Materials, Philadelphia. 92 pages. $3. Papers presented at ASTM's Third Pacific Area National Meeting, San Francisco, Oct. 1959. Subjects covered include: radioactive waste water, reactor cooling water, pollution problems, irrigation and water supply. The nuclear-energy field is represented by a paper describing in some detail the handling of radioactive wastes at General Electric's Hanford plant and by another detailing how the U. S. Geological Survey determines the concentration of radioactive materials in water. The increasingly popular topic of saline water conversion is also represented in this volume by papers on two of the

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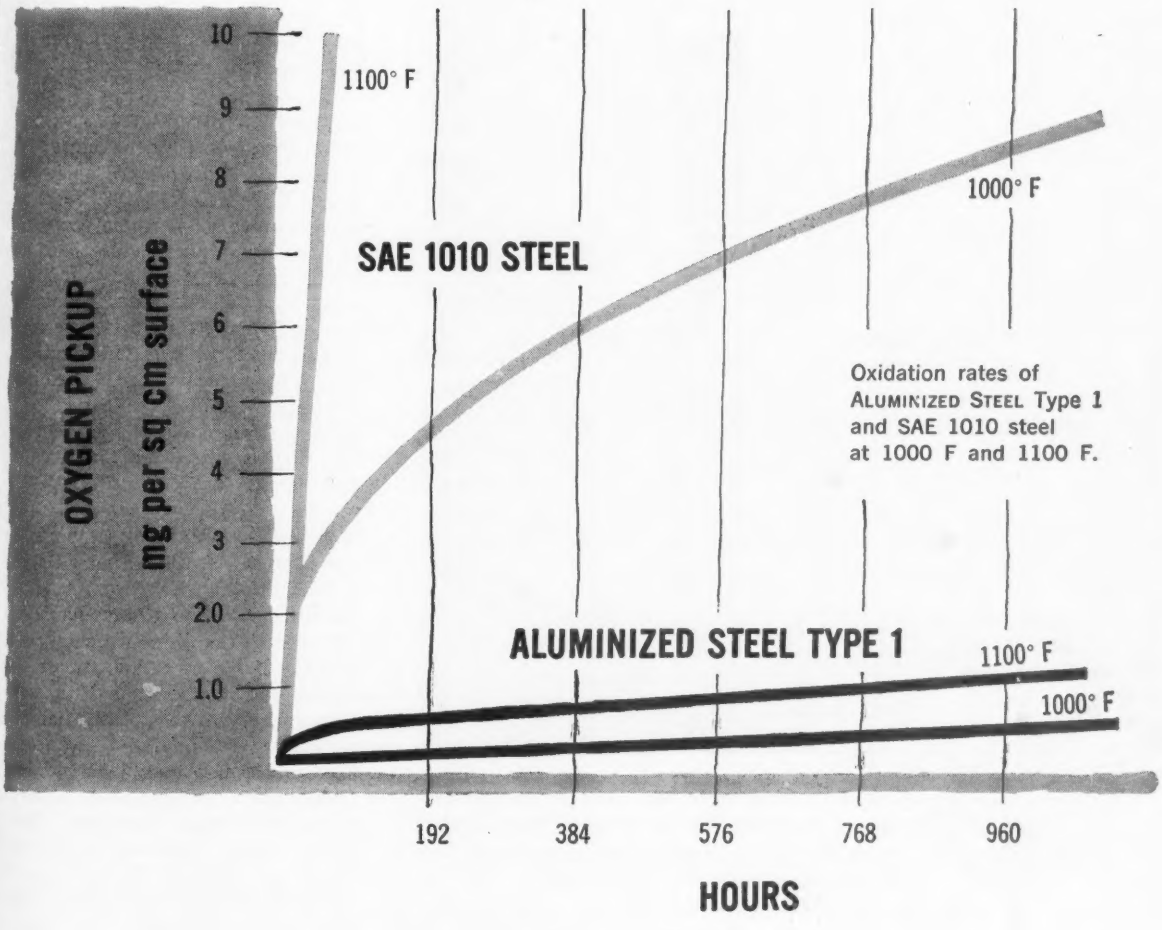

ARMCO Armco Division

current processes—electrodialysis and solar distillation. Although the range of coverage is small and the topics somewhat unrelated, this slim book contains a great amount of valuable technical information.

A MANUAL OF SEA WATER ANALYSIS. J. D. H. Strickland and T. R. Parsons. Fisheries Research Board of Canada, Ottawa, Ont. 185 pages. $2. This volume presents laboratory instructions for determining approximately 25 constituents of sea water, both organic and inorganic. Basic working instructions are given in the fullest detail. The book is designed specifically for the instruction and use of analysts undertaking oceanographic chemical analyses for the first time.

MICROBIOLOGY OF WATER AND SEWAGE. By P. L. Gainey and T. H. Lord. Prentice-Hall, Englewood Cliffs, N. J. 430 pages. $9.35. For the beginner in microbiology, this text book contains more than its title implies. In addition to numerous chapters on microorganisms and their study, there is information on chemical tests for pollution, both mechanical and chemical means for water purification and water softening, and a large section on sewage treatment and disposal.

WATER TREATMENT FOR INDUSTRIAL AND OTHER USES. 2nd ed. By E. Nordell. Reinhold. 528 pages. $12. The second edition of an exhaustive reference work that presents data and discussion of current practices in the conditioning of industry and community water supplies. Sample chapters: "Dissolved Gases," "Boiler Feed Waters," "Hydrogen Cation-Exchange Processes," "Aeration," "Chemical Feeders," "Sodium Cation-Exchange (Zeolite) Water Softening Process," and "Sedimentation, Coagulation, Settling and Filtration."

PROCEEDINGS, CONFERENCE ON PHYSIOLOGICAL ASPECTS OF WATER QUALITY: Sept. 8-9 1960. Ed. by H. A. Faber and L. J. Bryson. Public Health Service, Div. of Water Supply and Pollution Control, Research & Training Grants

Branch, Wash. 25, D. C. 244 pages. Free. Now available is the complete transcript of papers, messages and discussions at last year's conference in Washington. Topics include "Occurrence of Trace Elements in Water," "The Need for Water Quality Criteria," "Cancer Hazards From Natural and Artificial Water Pollutants," and "Detection and Analysis of [Inorganic] Chemicals in Water."

THE SEA OFF SOUTHERN CALIFORNIA—A Modern Habitat of Petroleum. By K. O. Emery. Wiley. 366 pages. $12.50. Of particular interest to petroleum engineers, this nevertheless is another book that has a misleading title in that it covers a much wider range than is suggested. Using the area as a perfect testing ground (every type of topographic condition exists), Emery has written a fine over-all oceanography text. Major sections are: physiography, lithology, structure, water, life, sediments (including organic constituents, chemical composition), economic aspects. Numerous figures and tables are included, as is a large foldout map showing relationship between the region's land- and submarine topography.

A HOLE IN THE BOTTOM OF THE SEA. By W. Bascom. Doubleday. 352 pages. $4.95. In the center ring of oceanographic derring-do is the Mohole project—drilling through the floor of the sea to pierce the earth's mantle. No one could be more qualified to describe the project's origin and its probable future than the author, the project's director. Though of direct pertinence to petroleum people, the technology involved is well worth any engineer's study.

THE SEA: IDEAS AND OBSERVATIONS. 3 vols. Ed. by M. N. Hill, E. D. Goldberg, C. O'D Iselin and W. H. Munk. Interscience. (In preparation.) Those interested in a general, and all-inclusive, text on oceanography might do well to wait for this 97-contributor set. First volume—physical oceanography—will be published next winter, will

treat such topics as: equations of state of sea water, interchange of properties between sea and atmosphere, dynamics of ocean currents, transmission of energy within the sea.

More New Books

The Impact of the New Physics. By F. Hinman. Philosophical Library. 174 pages. $4.50.

Radiation Chemistry of Gases. ACS Monograph 151. By S. C. Lind. Reinhold. 313 pages. $12.50.

Gas Sampling and Chemical Analysis in Combustion Processes. By G. Tiné. Pergamon. 94 pages. $6.

Glass Fibre Reinforced Plastics. Ed by A. de Dani. Interscience. 296 pages. $9.75.

Physical Chemistry of Process Metallurgy. Vol. 7, part 1. Ed. by G. R. St. Pierre. Interscience. 644 pages. $22.50; Vol. 8, part 2. 1,374 pages. $25.

Micro-Organisms as Allies—The Industrial Use of Fungi and Bacteria. By C. L. Duddington. Macmillan. 256 pages. $5.95.

Electronic Packaging With Resins. By C. Harper. McGraw-Hill. 339 pages. $11.

Nuclear Pulse Spectrometry. By R. L. Chase. McGraw-Hill. 221 pages. $8.50.

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PRO & CON . . .

continued from page 6

At another point he says that, in a spray dryer, "Exhaust air temperature controls the feed rate." This is fine as long as the material is being dried below the critical moisture content. On the other hand, if the required final moisture content is above the critical, exhaust air temperature cannot be used for control, because it is constant throughout the entire constant-rate period of drying.

Another trick of control design is occasionally necessary when the amount of recirculation of air is very high and the load variation is great. There may be such a long process lag from dryer control to heater control that an excessive temperature drop occurs. In such cases, a cascade control can be used, in which the heater is controlled by the temperature of the recirculating air stream before it enters the dryer, and the heater set-point is controlled by the dryer temperature itself.

NORMAN L. FRANCIS
Southern Research Institute
Birmingham, Ala.

Vibration vs. Power Cost

Sir:

Prof. Lemlich's article, "Vibration and Pulsation Boost Heat Transfer" (May 15, pp. 171-6), is an excellent summary of studies in that area to date.

I wonder how the increased heat-transfer rates compare on a power-consumption basis with other methods for increasing heat transfer. Swirling the fluid, inserting turbulators of various types, extending or roughening the surface, using wiper blades or fluid additives, or simply increasing the velocity in the original configuration—all are potentially competitive with the imposition of vibrations on the fluid and/or boundary. In many cases, the choice may be determined in large part by the incremental power consumption involved (if any).

Also, has a variable heat flux ever been imposed simultaneously

with a pulsing fluid? If the control is good enough to allow a good matchup of imposed flux and varying heat-transfer coefficient, the benefits would be a more-nearly constant wall temperature and an increase in the total heat transferred over a pulse cycle.

Add a vote for Lemlich's CEQ series; it is excellent.

W. R. GAMBILL
Oak Ridge National Laboratory
Oak Ridge, Tenn.

Sir:

Little has been recorded dealing with incremental power consumption. One reason is that many of the investigators have not been directly concerned with *process* heat transfer as such. Another is that in some situations the oscillations come "free" (at no cost), or nearly so, in already existing systems.

Nevertheless, a few studies have been carried out (Refs. 31, 64). Results are, for the most part, still inconclusive; they seem to indicate that the incremental power is sometimes large but can be reduced to modest proportions by proper application of the vibration or pulsation.

The answer to Mr. Gambill's second question is: indirectly, yes. Virtual constancy of wall temperature has been attained in a number of investigations by simply selecting a system in which the film resistance under study is the controlling resistance. The popular system of condensing steam vs. air is in this category. Furthermore, depending on the frequency, the thermal lag in the wall proper also helps maintain constant wall temperature. The cyclic matching up of flux with coefficient is thus automatic in such cases.

ROBERT LEMLICH
University of Cincinnati
Cincinnati, Ohio

Your comments and opinions are important. Send them to Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. They'll be welcomed.

Manufacturers' Literature

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Chemicals

Activated Carbon.....A complete line of activated carbons for every purpose. Design and prefabricate complete purification, separation & recovery systems. Bul. J-106.
R232 *Barneby-Cheney

Alcohols.....Latest in the series is hexyl alcohol. Specifications on the full line of alcohols or other high quality chemicals is available on request.
163 *Enjay Chemical Co.

Butyl Rubber Modifier.....New Pronar is a highly-active, non-discoloring modifier that makes possible the heat treatment of white & light-colored butyl. Information.
8-9d *American Cyanamid Co.

Chemicals.....Armoflo compounds are described in a new, revised edition of "Armoflo-Armour Anti-dusting & Anti-caking Chemicals" which is available.
14-15 *Armour Industrial Chemical Co.

Colloidal Silicas.....Properties and characteristics of Nalcoag colloidal silicas are described in Bulletin K5, which is now available on request.
209 *Nalco Chem. Co.

Filter Aid.....Celite filtration assures the right grade for every degree of clarity. Full details on how Celite gives the fastest, most efficient filtration.
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Fused Quartz.....Vitreosil has extreme heat resistance. Available in many types & sizes. Also fabricated to your special needs. Complete, illustrated catalog.
R217 *Thermal American Fused Quartz Co.

Hydrogen Peroxide.....With this bleach, white materials are clear with no reversion and dyed shades are brighter and stay that way. Information.
77 *Beco Chemical Div.

Modified Cellulose.....Cyanocel is the most efficient dielectric carrier that makes possible light without heat, glare or moving parts. Further information is offered.
8-9b *American Cyanamid Co.

N-t-Butylacrylamide.....Resins containing t-BAM can be applied from alcohol solutions—even in spraying formulations. Additional information is available.
8-9c *American Cyanamid Co.

Plastic.....Complete facts about Penton and a list of fabricators & suppliers of Penton processing equipment is available on request.
87 *Hercules Powder Co.

Sulfamide.....is similar to urea in many of its reactions, except that it is more acidic, and can act as a dibasic acid. Further information & a sample is available.
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Thickening Agent.....Microgel, the new thickening agent is used in the manufacture of Darina grease. Complete information on Microgel is available on request.
71 *Shell Oil Company

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T231 *Wall Colmonoy Corp.

Aluminized Steel.....Type 1 aluminized steel provides low-cost resistance to heat and corrosion, prevents destructive scaling up to 1250F. Information is offered.
196-197 *Armco Steel Corp.

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194 *Raybestos-Manhattan, Inc.

Industrial Insulation.....Mono-Block insulation is high in strength & minimizes loss due to breakage. Detailed information on Mono-Block is available.
173 *Baldwin-Ehret-Hill, Inc.

Packings.....for high temperatures and pressures. A new catalog is available showing the complete line of packing, tools, gasket materials.
200 *The Allpax Company, Inc.

Packings.....Chempro Teflon suspensoid impregnated asbestos packings have the chemical resistance of Teflon plus the strength of high grade asbestos. Bulletin CP552.
L232 *Chemical & Power Products

Pipe Insulation.....Snap-On is the only one-piece pipe insulation available in sizes from copper tubing to 36" IPS. More complete information is available.
181 *Gustin-Bacon Mfg. Co.

Pipe Insulation.....Metal-On is an aluminum-jacketed pipe insulation. Further information on Metal-On insulation is available to help solve your problem.
10-11 *Johns-Manville

Protective Coatings.....Technical data is available on Amercoat No. 99 including a cost analysis showing savings you can realize with this coating.
171 *Amercoat Corp.

Protective Coatings.....A technical booklet which is available gives uses and specifications of Nokorode Seal Kote and application techniques.
34 *Lion Oil Co., Div. of Monsanto

Refractories.....to answer your specific needs. Descriptive brochures may be had upon request to help in the selection of refractory materials for your job.
30-31 *Carborundum Co.

Silicone Coatings.....prevent sticking, cut costs, Syl-off coatings on paper and paper board simplify and speed handling. Information about properties & applications.
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Synthetic Rubber.....Reference booklet "Industrial Report on Viton Synthetic Rubber" contains heat and fluid resistance data and also physical and resistance properties.
93 *E. I. du Pont de Nemours & Co.

Thermoplastic Sheetings.....A wide range of materials are used in these thermoplastic sheetings. Complete information on specific types of Seilon is available.
206 *Seiberling Rubber Co.

Wire Cloth.....Whatever metal or alloy needed in any size or quantity to the closest tolerances. High mesh counts are featured. A catalog is available.
52 *Cambridge Wire Cloth Co.

* From advertisement, this issue

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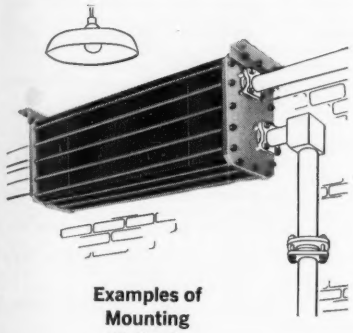
National Carbon representatives expand your engineering force

F. J. ANDERSON
Sales Engineer

Mr. Anderson joined the Carbon Products Sales department of National Carbon Company in November, 1951. Since 1952, he has represented the company in the Charleston, W. Va., Pittsburgh, and Houston territories, being active in Brush and Railroad Sales and more recently in Chemical Product Sales.

Mr. Anderson served in the Army Air Force 1943-1946, and was graduated from Fenn College with a B.S. degree in Chemical Engineering.



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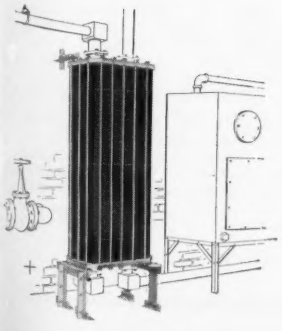
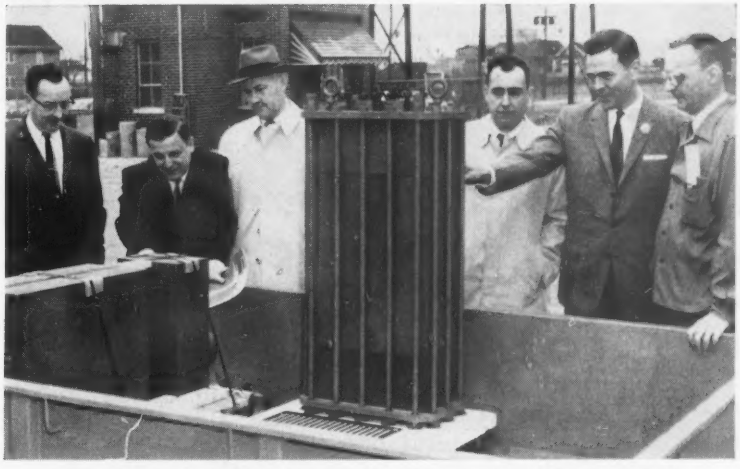


Chemical Processing Personnel See Construction Features of New "KARBATE" Heat Exchanger



Personnel of Becco Chemical Division, Food Machinery and Chemical Corporation, Tonawanda, New York, being shown National Carbon Company's new "Karbate" impervious graphite heat exchanger Type CFB. Left-to-right in photo: H. G. Hyatt, Production Co-ordinator; J. F. Revilock, Manager, Process Equipment Sales, National Carbon Company; C. Keller, Assistant Purchasing Agent; J. Worrell, Plant Engineer; E. R. Hogan, Jr., Sales Engineer, National Carbon Company, Reid Garver, Engineering Development Supervisor.

Plant-site demonstrations of the new "Karbate" counterflow block heat exchanger are proving a helpful time-saver for chemical processing personnel concerned with the problems of corrosive heat transfer.

The trailer-mounted unit, demonstrated by NATIONAL CARBON's sales and service engineers, gives a close-up view of the construction of the CFB and expedites appraisal of its operating advantages.

"Karbate" Impervious Graphite Heat Exchanger Type CFB Provides Versatility in Mounting and Easy Installation

The Type CFB heat exchanger provides unsurpassed corrosion resistance and unique counterflow design. In addition, it can be installed vertically or horizontally, in a wide range of floor, wall, and ceiling positions. This advantage is particularly valuable where floor area, building construction, and proximity to other processing equipment put a premium on operating space.

The CFB measures only 13 inches by 21 inches in cross-section. When installed vertically it provides more heat transfer area per square foot of floor space than any other block type exchanger.

A variety of pass arrangements and a selection of heat transfer areas, ranging from 28 to 210 square feet, make it easy for the engineer to design the new "Karbate" Type CFB heat exchanger into his process system.

For detailed information on the features of this equipment, write for a copy of **Catalog Section S-6813.**

"National", "Union Carbide", "N" and Shield Device and "Karbate" are registered trade-marks for products of

NATIONAL CARBON COMPANY

UNION CARBIDE

LITERATURE . . .

Electrical & Mechanical

Cable.....MI cable is ideally suited for all types of trouble areas. The many unique characteristics of this versatile cable construction in the new MI catalog.
165 *General Cable Corp.

Lighting Fixtures.....Catalog covers lighting for every need: bench, area, flood; incandescent, fluorescent, mercury vapor; permanent, portable.
56 *Crouse-Hinds

Motors.....Key manufacturing operations employed in maintaining the required close tolerances are described in "The Fine Art of Building Better Motors".
182 *Elliott Company

Plugs and Receptacles.....Versatile, precision manufactured plugs and receptacles for hundreds of industrial applications. AE series assures lasting heavy-duty service.
1 *Appleton Electric Co.

Speed Drives.....Adjustable-speed drives in sizes from ½ to 2500 hp. Information is contained in Bulletin 2900, Adjustable Speed Drives, which is available.
104 *The Louis Allis Co.

Handling & Packaging

Automatic Scales.....Technical bulletin on how automatic bagging and proportioning scales are promoting good housekeeping, controlling quality, etc.
192 *Richardson Scale Co.

Bags, Multiwall.....with the Bemi-Strip closure. Complete information on this new closure which will be available nationally in a few months may be had upon request.
69 *Bemis Bro. Bag Co.

Chain.....designed for hard service whether employed for power transmission, conveying or digging. Engineering assistance in applying this chain to your equipment.
42 *Jeffrey Manufacturing Co.

Cylinders.....The new Hackney cylinder catalog, the most complete data file of its kind on modern cylinders for compressed gases is available on request.
4 *Pressed Steel Tank Co.

Feeders.....Rotary airlock feeders for use in handling problems of dust control and for pneumatic conveying. Bulletin P58 available upon request.
B219 *Prater Pulverizer Company

Loading Arms.....Spring-balanced loading arms for fast, safe loading of petroleum and chemical products. The latest facts are contained in Bulletin F-356.
91 *Continental-Emsco Co.

Pneumatic Conveying Systems....New bulletin M-260 discusses types of systems, illustrates & diagrams high and low density arrangements. Shows equipment & gives all details.
176a *The Day Co.

* From advertisement, this issue

LITERATURE . . .

Pneumatic Conveying Systems.....All standardized components, capacities & horsepower requirements are shown in Bulletin 228 which is available on request.
190 *Sprout, Waldron & Co., Inc.

Scales.....Printweigh are available in a wide range of models including Portable, Floor & Bench types, Built-in Hopper, Overhead Track & Motor Truck types. Bul. 2017.
212 *Toledo Scale Corp.

Storage Tanks.....A 12 pg. bulletin describes horizontal & vertical storage tanks. Filled with photos of various installations plus description of auxiliary equipment.
176b *The Day Co.

Tractor Shovels.....Michigan Tractor Shovels are available in a wide variety of models for excellent performance and economy. Further information is available.
48 *Clark Equipment Co.

Heating & Cooling

Air Conditioners.....keeps its promise of precision. Complete information on Type "A" air conditioners is contained in Bulletins 58 & 122.
T219 *Niagara Blower Company

Air Preheaters.....Ljungstrom package air preheaters for use on boilers from 25,000 to 250,000 pounds of steam per hour. Details in 14-page booklet.
92 *The Air Preheater Corp.

Boilers.....Powermaster boilers give you the fastest return on your investment. Burner systems are also available. Further information in Bulletin 1260.
47 *Orr & Sembower, Inc.

Boilers.....Bulletins describe the Modulatic Water Tube Boilers. Furnish high or low-pressure steam (at design pressures up to 1000 psi, or even higher).
41a *Vapor Heating Corp.

Cooling Tower.....is completely free of structurals below the roof trusses. New Rigid-Bent design features tapered built-up columns outside the tower. Inform.
155 *Foster Wheeler Corp.

Furnace.....for oxo-synthesis service. Technical details are contained in a paper, "Catalytic Steam Reforming Production of Hydrogen & Synthesis Gas."
44 *Selas Corp. of America

Heat Control.....Equipment such as temperature-presure regulators, float thermostatic steam traps, thermo-dynamic steam traps & pipeline strainers for heat control.
100 *Sarco Company, Inc.

Heat Exchanger.....Roto-Fin heat exchangers offer high-volume conduction cooling or heating in a simple, compact design. Folder 2911 is available.
37 *Link-Belt Company

Heat Exchangers.....Type OC heat exchangers have removable tube bundles with an internally packed floating head. Sizes from 6" through 30" diameters.
99 *Bell & Gossett Co.

* From advertisement, this issue

LITERATURE . . .

Heat Transfer.....Platecoil saves on engineering, fabricating and installing in comparison with pipe coils. Greater heat transfer capacity permits compact units. Bul. P61.
83 *Platecoil Div., Tranter Mfg.

Heating & Cooling Fins.....feature high ratio of surface area to face area and high air velocities without excessive friction or turbulence. Bulletin S-55.
210 *Aerofin Corp.

Liquid Phase Heater.....Hi-R-Temp liquid phase heaters are completely unitized and skid mounted. Eliminate need for water treatment. Information is available.
41c *Vapor Heating Corp.

Make-Up Air Systems.....Fans bring in outside air, and heaters temper it. Cancels out vacuum, gives balanced heat & ventilation. A booklet is available.
109 *Sturtevant Div., Westinghouse

Scraped Surface Exchangers.....solve special heat transfer & crystallization problems. Units fabricated from a broad range of materials. Literature.
122 *Henry Vogt Machine Co.

Steam Superheaters.....are compact, with automatic operation and feature constant temperature control. Completely assembled & wired. Information is offered.
41b *Vapor Heating Corp.

Instruments & Controls

Comparator.....Handbook, "Modern pH & Chlorine Control" gives theory and application of pH control. Illustrates and describes full line. Available on request.
L230 *W. A. Taylor & Co.

Computer.....Recomp 111 is the newest low-cost compact digital computer. Full information is available on its proven performance and quality.
204 *Autonetics Div. of N. American

Computer.....The new GE412 digital control computer has been designed with the total systems concept & flexibility of equipment organization in mind. Details.
12-13 *General Electric Co.

Liquid Level Control.....Level-Trols for accurate, trouble-free control on a wide range of applications. Three basic controllers available. Information.
96-97 *Fisher Governor Co.

Meters.....guard your liquid inventories and control the flow of industrial liquids. You'll have accurate records of costs plus other advantages.
20-21 *Rockwell Mfg. Co.

Meters.....Advantages of both rotary-positive-displacement metering & line-mounting in a 7000 cfh Rootsmeter, Model 7M125 as well as the 3000 cfh model. Details.
43 *Roots-Connersville Blower

Meters.....Varea-Meters feature a wide capacity selection. Transmitters, magnetic indicators & the usual accessories are available. Further information is offered.
179 *Wallace & Tiernan, Inc.

* From advertisement, this issue

* From advertisement, this issue

We're on page 85

LITERATURE . . .

Transmitter.....A DP transmitter of many uses, the 212T is available in indicating and non-indicating models. Further information is contained in Bulletin 98413.
28-29 *Taylor Instruments Companies

Pipes, Fittings & Valves

Alloy Tubing.....Incoloy alloy tubing withstands furnace temperatures of 1400 F. to 1800 F. A helpful booklet, Incoloy Extruded Tubing in the Petrochemical Industry.
106 *International Nickel Co., Inc.

Ball Valves.....Double-Seal ball valves are available in a wide variety of materials and sizes for many applications. Literature is offered.
101 *Jamesbury Corp.

Ball Valve.....The Econ-O-Mizer is available in sizes from ¼" to 6" and is ideally suited to difficult media because of its smooth round flow & leakproof shut-off.
79 *Worcester Valve Co., Inc.

Butterfly Valves.....Resilient seated butterfly valves save space, save weight, save cost and save trouble. Control may be manual or automatic. Bulletin 590X.
L234 *W. S. Rockwell Co.

Pipe.....Aluminum process pipe is strong, lightweight and corrosion-resistant. Offers many advantages over ordinary pipe. A complete literature file is available.
100 *Reynolds Metals Co.

Pipe, Pyrex.....comes in all standard sizes and fittings. You can see through the pipe wall into the flow area. Further information in Bulletin PE-3.
36 *Corning Glass Works

Pipe & Fittings.....The exact same alloys can be furnished in fittings & flanges as well as pipe. Further information is to be found in Bulletin FB78.
95 *Babcock & Wilcox Co.

Plastic Pipe.....for excellent resistance to over 300 chemicals. To help you make major pipe savings, the new Plastic Pipe Fact-pak is available on request.
208 *Carlon Products Corp.

Plastic Pipe & Fittings.....to combat corrosion. Installation costs are lower and fewer replacements are required. Further information upon request.
199 *Kraloy-Chemtrol Co.

Plug Valves.....are non-lubricated & non-sticking. Hamer plug valves gives maximum service with minimum maintenance. New and complete Hamer valve Catalog 60 is offered.
218 *Well Equipment Mfg. Corp.

Spray Nozzles.....in a great variety of sizes and types. Catalog 24, a forty-eight page reference manual is available and may be had upon request.
TL *Spraying Systems Co.

Through-Conduit Gate Valves.....Full information is available on these easy-operating high-pressure valves. Tight mechanical seal in either open or closed position.
107 *W-K-M Div., ACF Industries

* From advertisement, this issue

LITERATURE . . .

Tubing.....You can count on welded carbon or stainless steel tubing in critical heat transfer applications. Booklet 8591 is offered for further information.
38 *Welded Steel Tube Institute

Tubing and Pipe.....Seamless, stainless tubing and pipe is now available. A new Selecting and Buying Guide, Bulletin TD128 may be had upon request.
16-17 *The Carpenter Steel Co.

Valve....Non-lubricated "O-Seal' valve is guaranteed not to stick. Complete range of sizes and types available. Complete details on request.
39 *Wedgeplug Valve Co.

Valve Manifolds.....RegO safety relief valve manifolds cost far less to buy, far less to maintain. Pop-action design keeps product loss to a minimum.
205 *The Bastian-Blessing Company

Valves.....for the control of hot, cold, erosive, corrosive or viscous fluids. Designed to accept all standard actuators. General Catalog 1500-E is available.
89 *The Annin Company

Valves.....600-pound steel gate, globe, angle and check valves in sizes ¼" to 2" in forged and cast steel. Details on the complete line are available on request.
85 *Crane Co.

Valves.....Sleeveline valves offer a larger sealing area, better adjustment, no pocket to collect liquids & solids. Further information in Bulletin V/14.
169 *The Duriron Co., Inc.

Valves.....for fast, easy opening and closing with a leak-proof seal & straight-through flow with minimum pressure drop. Informative bulletin is available.
67 *Everlasting Valve Co.

Valves.....Forged steel valves are available on all lines up to 2 in. Designed to meet control requirements with minimum replacement & maintenance. Information.
45 *Ohio Injector Co.

Valves, Gate.....are made in various alloys, types and sizes for most services...and for all pressures. Additional information contained in Catalog No. 57.
33 *Darling Valve & Mfg. Co.

Process Equipment

Centrifugal.....The new Model HS 40 W pressure centrifugal features completely and readily accessible interior. Complete specifications are available.
149 *Baker, Perkins, Inc.

Crystallization Equipment.....Details on crystallization equipment can be modified to meet your exact need in your application are available on request.
111 *Struthers Wells Corp.

Drying Equipment.....Kathabar equipment for toasting, drying or cooling. Complete data is available on request for further information on these systems.
174 *Surface Combustion

* From advertisement, this issue

LITERATURE . . .

Feeder.....Merchen feeder gives you greater feeding accuracy because of its sensitivity. It is compact & gives you hour-to-hour accuracy for feeding & blending. Inform.
178 *Wallace & Tiernan, Inc.

Mill.....Vibro-Energy mill wet-grinds particles from 60 mesh to one micron or smaller. An illustrated technical paper is available for further details.
153 *Southwestern Engrg. Co.

Mills..... Complete information on "Jet-O-Mizer" Mills, "Jet-O-Clone" Dust Collectors, and testing and custom grinding services is now available on request.
175 *Fluid Energy Processing & Equip.

Mixers.....The new Hi-Flo Lightnin mixers are made in a full range of sizes up to 50 hp. Details are contained in Bulletin B-526 which is available.
236 *Mixing Equipment Co.

Mixers.....Dependable mixing is assured to give you more profit in your process. Used for agitating, mixing, reacting, suspending solids & other applications. Bul. 581.
177 *Nettco Corp.

Mulling.....Simpson Mix-Muller is specifically designed to put you in control of mixed properties. The Handbook on Mulling is available on request.
119 *National Engineering Co.

Process Centrifuges.....perform separations of types and efficiencies not previously possible. A booklet on centrifuge types and their applications is available.
24-25 *De Laval Separator Co.

Process Equipment.....Catalog shows equipment for homogenizing, heating, cooling, flavorizing, storing, separating, freezing, mixing, packaging and conveying.
51 *Cherry-Burrell Corp.

Process Equipment.....Glascote efficient, economical, reliable glass-lined processing equipment is described in Bulletin 105 which is available.
22-23 *Glascote Products, Inc.

Process Equipment.....such as dryers, coolers, combination ammoniator-granulators, furnaces, cookers, reactors, presses and pilot plants. Literature is offered.
184 *Edw. Renneburg & Sons

Scrubbing Towers.....Hydraulic scrubbing towers are highly efficient, specially designed to solve your fume removal problems. Details are available.
35 *Buffalo Forge Company

Vacuum Tumble Dryers..... Catalog 16-P contains complete technical information on vacuum tumble dryers, Twin-Shell blenders and the new solids-processor.
58-59 *Patterson-Kelley

Pumps, Fans & Compressors

Acid Pumps.....in 1" to 8" discharge sizes with 10 to 3000 GPM capacities, heads to 200' and higher. Pumping parts are available in a variety of alloys and plastic.
235 *A. R. Wilfley & Sons

* From advertisement, this issue

Compressor.....The CRX carbon piston compressor does not require oil or water lubrication. Learn the details from Bulletin CRC-10. All types of compressors available.
103 *Gardner-Denver Co.

Compressor, Centrifugal.....available in multi-stage type for volumes up to 100,000 cfm . . . in barrel types for air or gas supply at pressures up to 5000 psi. Details.
113 *Cooper Bessemer

Compressors, Centrifugal.....Model G centrifugal compressors are available in capacities from 500 to 15,000 cfm, for 4 to 20 psig duty on air service Bulletin 2564-11.
167 *Joy Mfg. Co.

Gas Compressor.....Two-stage gas compressor for pressures to 20,000 psi. Ideal for laboratory, pilot plant or circulating compressor service. The latest catalog is offered.
216 *McCartney Mfg. Co., Inc.

Midget-Centrifugal Pumps.....Your guide to a broad line of midget-centrifugal pumps and stirrers for the laboratory is Bul. 400 which is available.
81 c *Eastern Industries, Inc.

Plug Units....Thermal-Aire plug units designed to work in high-temperature applications without duct work. Information is contained in Bulletin 960.
TR 220 *Garden City Fan & Blower Co.

Pump.....Gearchem pumps for temperatures to 400 F, viscosities to 10,000 SSU, capacities to 10 gpm, pressure to 100 psi. Literature is available.
40 a *Eco Engineering Co.

Pump, Diaphragm.....for those hard-to-handle fluids; corrosive, abrasive, viscous, thick, heavy, etc. Easy to clean. Bulletin 148 is available.
R 215 *T. Shriver & Co., Inc.

Pump, Vacuum.....The new Series H Microvac pump is designed for compactness. Information about this type plus a Vacuum Slide Calculator are offered.
180 *F. J. Stokes Corp.

Pumps.....for hard-to-handle liquids in the chemical industry. Pumps range from 25 to 2500 hp., pressures to 50,000 psi. Additional information is available.
115 *Aldrich Pump Company

Pumps. . ....satisfy virtually all pumping requirements and feature higher speeds, non-overloading power characteristics and steep head-capacity stability. Colorful booklet.
186 *Johnston Pump Co.

Pumps.....A 50-page booklet, "Rotary & Centrifugal Pumps: Theory and Design", bulletin G-2666 is available to help in the selection of pumps for your application.
Cov *Worthington Corp.

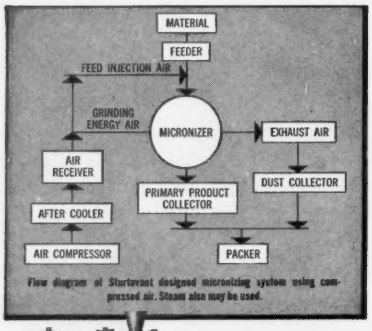
Pumps, Centrifugal.....to solve your processing problem. All the models and useful engineering data are included in Bulletin 130 which is available on request.
81 a *Eastern Industries, Inc.

Pumps, Displacement.....with flow rates from ½ gpm to 5½ gpm, pressures from 30 to 200 psi. High pressure outputs with small, low power units. Bul. 220.
81 b *Eastern Industries, Inc.

* From advertisement, this issue

Need ½ to 44 Microns?

Sturtevant Micronizers* Make 325 Mesh Obsolete



Flow diagram of Sturtevant designed micronizing system using compressed air. Steam also may be used.

One Operation Reduces, Classifies

Sturtevant Micronizers grind and classify in one operation in a single chamber—provide fines in range from ½ to 44 microns to meet today's increased product fineness needs. Can handle heat-sensitive materials.

Production Model (15 in. chamber)

No Attritional Heat

Particles in high speed rotation, propelled by compressed air entering shallow chamber at angles to periphery, grind each other by violent impact. Design gives instant accessibility, easy cleaning. No moving parts.

Classifying is Simultaneous

Centrifugal force keeps oversize material in grinding zone, cyclone action in central section of chamber classifies and collects fines for bagging. Rate of feed and pressure control particle size.

Eight Models Available

Grinding chambers range from 2 in. diameter laboratory size (½ to 1 lb. per hr. capacity) to large 36 in. diameter production size (500 to 4000 lbs. per hr. capacity). For full description, request Bulletin No. 091.

Engineered for Special Needs

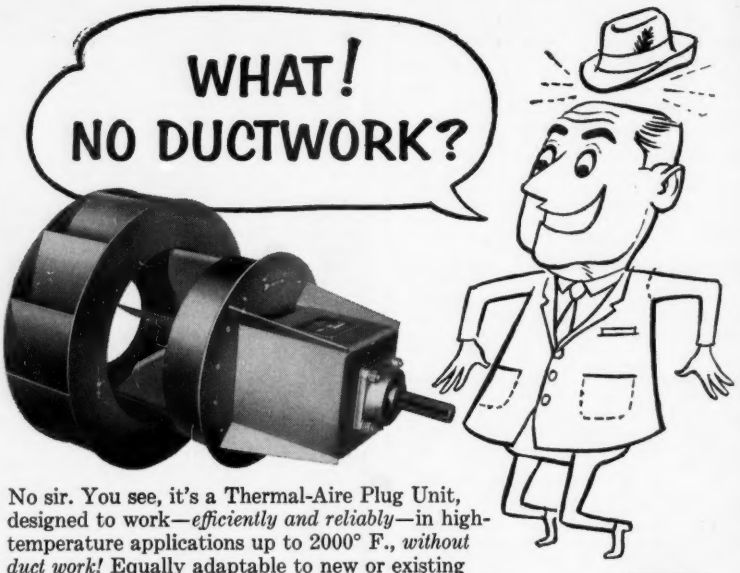
A 30 in. Sturtevant Micronizer is reducing titanium dioxide to under 1 micron at feed rate of 2250 lbs. per hr. For another firm, a 24 in. model grinds 50% DDT to 3.5 average microns at a solid feed rate of 1200-1400 lbs. per hr. A pharmaceutical house uses an 8 in. model to produce procaine-penicillin fines in the 5 to 20 micron range. Iron oxide pigment is being reduced by a 30 in. Micronizer to 2 to 3 average microns.

Sturtevant will help you plan a Fluid-Jet system for your ultra-fine grinding and classifying requirements. Write today.

Can Test or Contract Micronizing Help You?

Test micronizing of your own material, or production micronizing on contract basis, are part of Sturtevant service. See for yourself the improvement ultra-fine grinding can contribute to your product. Write for full details. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

*REGISTERED TRADEMARK OF STURTEVANT MILL CO.

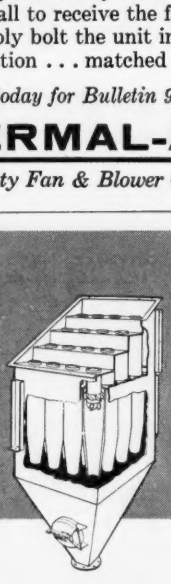


No sir. You see, it's a Thermal-Aire Plug Unit, designed to work—*efficiently and reliably*—in high-temperature applications up to 2000° F., *without duct work!* Equally adaptable to new or existing furnaces, ovens, kilns, etc., Thermal-Aire Plug Units are quickly and easily installed. Provision of a hole in furnace wall to receive the fan wheel is the only requirement. Then simply bolt the unit in place for dependable, low-cost air circulation . . . matched to *your* job requirements.

■ *Write today for Bulletin 960*

THERMAL-AIRE PLUG UNITS

Garden City Fan & Blower Co. 841 N. Eighth St. Niles, Michigan



Traps MORE dust at LESS cost MULTICLONE mechanical dust collector

If **cyclonic collection** will clear your dust problem—a **Multiclone** by Western Precipitation will do it best.

HIGH EFFICIENCY. Multiple **small**-diameter collectors—a WP-pioneered feature—generate greater centrifugal forces for higher separating efficiency.

MORE ECONOMY—all along the line. Basic cost, installation, housing, maintenance all are less. No costly, complicated ducting. Highly adaptable units can often be fitted into existing structures. No moving parts—and cast iron tubes and vanes **last.**

MORE INFORMATION? For literature, write Western Precipitation, 1000 West 9th Street, Los Angeles 54, California. (In Canada write 8285 Mountain Sights Avenue, Montreal, P.Q.)

Dust and fume control since 1907

WESTERN PRECIPITATION

DIVISION OF JOY MANUFACTURING COMPANY

EMPLOYMENT OPPORTUNITIES

(Continued on following page)

SALES ENGINEERING CAREERS IN CHEMICAL PROCESS CONTROL

The Foxboro Company, leading manufacturer of instrumentation and control systems for the chemical process industries, has immediate openings for sales application engineers at its home office.

Responsibilities will include coordination of sales effort for the chemical industries including some customer contact, plus application engineering on pneumatic and electronic control systems.

B. S. degree in Chemical Engineering, Electrical Engineering, or Mechanical Engineering preferred, with at least 3 years' experience as a project or instrument engineer in the process industries. Sales engineering experience is also desirable.

Of the 2600 Foxboro people employed at the main office and plant, more than 450 are graduate engineers. The Company is located in a suburban community, within easy driving distance of metropolitan Boston and Providence. Its operation is international, progressive, and steadily expanding.

If an opportunity like this appeals to you, and if you believe you are qualified, please mail an outline of your education and experience to

W. W. Brown,
Employment Manager

THE FOXBORO COMPANY
FOXBORO, MASSACHUSETTS

PHYSICAL CHEMIST

$10,000—$12,000

To make theoretical analysis of the effects of physical electrical and chemical environments on solid state devices. Exceptionally good concern. Fee paid.

CONTACT LEW MUSGRAVE
MONARCH PERSONNEL
9 East Jackson Blvd. Chicago 4, Illinois

SALES ENGINEER

Experienced in Filter Application Design and Operation.

Excellent Opportunity. Must be willing to relocate. Send full resume to:

P-6941, Chemical Engineering
645 N. Michigan Ave., Chicago 11, Ill.

LITERATURE . . .

Pumps, Glassed.....Full details on this glassed pump is contained in Bulletin 725.2 which is offered along with booklet, "It's What's Inside That Counts."
207 *Goulds Pumps, Inc.

Pumps, Proportioning.....Feed precisely metered fluids or slurries in all ratios with controlled process variables. Bulletin covers 100 series and 200 series.
213 *American Meter Co.

Pumps, Vertical Turbine.....for every pumping requirement. Bulletin 200 describes the oil-lubricated model and Bulletin 201 describes the water-lubricated.
157 b *Layne & Bowler, Inc.

Services & Miscellaneous

Ammonia Absorption System.....uses waste heat for process cooling. Can operate unattended for long periods. Also adaptable for ammonia recovery.
114 *York Corp.

Casters & Wheels.....All types of rubber treads for smooth operation on all kinds of floors. A new manual is offered describing nearly 4,000 types.
R 233 *Darnell Corp.

Cleaning Service.....offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. Information offered.
75 *Dow Industrial Service

Compacting Process.....produces granules that are more uniform in size, that flow free and won't fracture or abrade in handling. Complete information is offered.
159 *Allis-Chalmers

Crayons & Paints.....Thermochrom crayons & Dectectotemp paints show the temperature by changing to a distinct, totally different color. A colorful folder is available.
R 214 *Curtiss Wright Corp.

Fire Fighting Products.....To step up your department's life-saving power, equip with FOAM systems, nozzles and FOAM liquid. Complete details are available.
46 *Rockwood Sprinkler Co.

Gravel Wall Well.....Bul. 900 gives a complete explanation of gravel wall well construction & accompanying shutter screen use. Also complete specification data.
157 c *Layne & Bowler, Inc.

Laboratory Furniture.....A new 40-page catalog provides a quick reference implement for basic planning of laboratory & hospital installations. Available on request.
214 *S. Blickman, Inc.

Professional Development.....A booklet, "Public Speaking" is one of a series on professional development for engineers. A copy may be had on request.
L 233 *Western Supply Co.

Water Service.....The most complete vides undivided responsibility for the delivery of water—of quality & quantity required. Bul. 10. required. Bul. 10.
157 a *Layne & Bowler, Inc.

* From advertisement, this issue

Be sure to see our family portrait on page 85

PROFESSIONAL SERVICES

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 645 N. Michigan Ave.
SAN FRANCISCO 11: 255 California St.

POSITION VACANT

Wanted: Foreman for lead oxide plant. Should have experience in the manufacture of battery oxides, and should possess the highest references for character, reliability and competence. Write complete work history, education, references and salary desired. Dixie Lead Company, Box 8625, Dallas 16, Texas.

EMPLOYMENT SERVICES

Better Positions—$6,000 to $50,000. Want a substantial salary increase, more opportunity or different location? This national 50 year old service connects you with best openings. You pay us only nominal fee for negotiations; this we refund when employer pays placement fee. Present position protected. In complete confidence, write for particulars, R. W. Bixby, Inc., 653 Brisbane Bldg., Buffalo 3, N. Y.

POSITION WANTED

Management — Chemical Engineer Experienced plant manager, plant-production superintendent. Broad chemical, fats and oils, food experience. PW-6851, Chemical Engineering.

ADDITIONAL EMPLOYMENT ADVERTISING on page 221

Equipment Searchlight

CE's Searchlight spots the big bargains in used, resale and rented equipment. Check this issue's listings—most complete in the field—for items you need now.

▶ **Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing date**—August 7th issue closes July 14th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

FOR SALE

$.0015X^3 + .030X^2 + .18X + 1 = 0$ reduced to $(.0224X^2 + .113X + 1)(.067X + 1) = 0$ in 20 seconds with the Cubic Solver. Reduce cubics easy and quick to $(AX^2 + BX + 1)(CX + 1) = 0$. Send $2.98—F. W. Jackson, 318 Maple Ave., Drexel Hill, Pa.

LIQUIDATIONS

OHIO

2—Kilby NICKEL Dbl. Effect Evaporators, 2000 sq. ft. ea. effect.
1—Kilby NICKEL Single Effect Force Feed Evaporator, 1200 sq. ft. Above with condensers, piping and pumps.
2—12,000 gal. NICKEL Clad Tanks, 12'x14'.
5—8,500 gal. NICKEL Clad Tanks, some agitated.
1—1,000 gal. NICKEL Clad Tank, 5'x8'.
2—Oliver 5'3"x4' NICKEL Clad Rotary Vacuum Salt Type Filters.
2—Pfaudler 300 and 200 gal. Glass Lined Jacketed Agitated Reactors.
1—Sperry 30" C.I. Filter Press, 27 chambers.
1—Buflovak 32"x90" Double Drum Dryer.
4—Feinc 8'x12' Rotary Vacuum Steel Filters, string discharge.
1—Peabody Gas Scrubber stainless steel 11,000 CFM at 145°F with fans and XP motor.
1—Peabody Gas Scrubber stainless steel 6,000 CFM at 125°F with fan and XP motor.
2—6'6" dia. x 60' Rotary Dryers.
1—5½'x4½'x50' Rotary Dryer.
1—5½'x4½'x60' Rotary Dryer.
3—Dorr 80' dia. Thickeners with agitator and drive.
4—Dorr 40' dia. Thickeners with agitator and drive.
3—Vogt 387 sq. ft. Rotary Pressure Filters.
2—Chicago Pneumatic 26" x 14" Vacuum Pumps with 150 HP motors.
3—Fuller Kinyon Pumps H5 and H6.
1—Link-Belt 24" x 90' Troughing Belt Conveyor.
5—NICKEL Centrifugal Pumps, 2", 3".

1—Raymond #73612 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.
1—Raymond #6669 Super High Side 6-Roll Mill, with whizzer, cyclone, piping and motors.
1—Raymond 12' dia. Double Whizzer Air Separator.
2—Sturtevant 14' dia. Air Separators.

BRILL FOR VALUES

CENTRIFUGES

2—Sharples C-20 and C-27 Super-D-Hydrator, 316 S.S.
1—Bird 18" x 28", Solid Bowl, Continuous, 304 S.S.
2—Bird 24" x 38" Solid Bowl Continuous 304 S.S.
1—Bird 40" x 60" Solid Bowl Continuous, 316 S.S., unused.
3—Sharples PY14, PN14 Super-D-Canters 316 S.S.
2—Sharples #16, 304 S.S., 3 HP motor.

REACTORS—EVAPS—CONDS—TANKS

1—Pfaudler 125 gal. 304 S.S. Jacketed Agitated Reactor, 150# int., 125# jacket.
3—Pfaudler 200 gal. glass lined jacketed Kettles.
2—Pfaudler 850 and 650 gal. Steel Jacketed, Agitated Reactors.
1—650 gal. 304 S.S. Reactor with 100 sq. ft. Bayonet Heater.
1—O. G. Kelly 3000 sq. ft. 309 S.S. force speed Evaporator UNUSED.
1—550 sq. ft. Buflovak monel single effect Evaporator.
10—400 to 1200 gal. vertical 304 S.S. Tanks, open end closed.
6—7500, 6000 and 2000 gal. Rubber Lined Tanks.
1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.
1—2000 gal. horiz. 304 S.S. Tank, 5' x 12'.
1—2500 gal. vertical 304 S.S. Tank, 8' x 7'.
1—10,000 gal. rubber lined Tank 10' x 17'6".
5—2700, 2200 gal. 304 S.S. Vertical Agitated Tank with Coils.
1—4200 gal. 316 S.S. Vertical Tank, 8' x 12'.
1—5500 gal. 316 S.S. Clad Pressure Tank, 250 psi.
1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36', 200 psi.
4—Stainless Heat Exchangers; 536, 370, 315, 250 sq. ft.
1—24" dia. x 35', 304 S.S. Bubble Cap Col.

FILTERS

1—#5 Sweetland Filter 304 S.S. 120 sq. ft.
1—Oliver 6' dia. Horizontal Filter, 316 S.S.
1—Oliver 4' dia. Monel Horizontal Filter.
1—Oliver 5' x 6' Steel Rotary Vacuum Precoat Filter.
1—U.S. 200 sq. ft. 304 S.S. Auto-Jet Filter.
1—Hercules 400 sq. ft. 304 S.S. Pressure Filter.
1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaportite housing.
1—Feinc 3' x 1' 316 S.S. Rotary Vacuum Filter.
2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

DRYERS

1—Buflovak Vacuum Shelf Dryer with 17—60" x 80" shelves.
2—Buflovak 42" x 120", atmospheric double drum Dryers, complete.
1—Buflovak 32" x 90" Atmos. Twin Drum.
2—Devine 4' x 9' single drum, atmospheric Dryers.
2—Devine 4' x 9' single drum, atmospheric.
1—Buflovak 3' x 10' Rotary Vacuum Dryer.
1—Stokes 4' x 20', 304 S.S. Rotary Vacuum.
6—Louisville Rotary Steam Tube 5' x 25', 6' x 30', 6' x 50' Dryers.
2—Louisville 8' x 50' Stainless Steel lined Rotary Dryers.
9—Rotary Dryers 3' x 36', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
1—Louisville 4½' x 25' Inconel Rotary Dryers.
2—Link Belt, 7'5" x 25', 6'4" x 24", S.S. Louvre Dryers.
1—Stokes model 38-A Tray Dryer with 16—36" x 36" S.S. Shelves.
2—Atmos. Tray Dryers, 16 shelves, 40" x 24".
2—10' and 4' dia. 304 S.S. Spray Dryers.
2—Wyssmont Dryers, 304 S.S. 6'2" and 9'6" dia.

MIXERS

1—Abbe 110 gal. 304 S.S. Jacketed Agitated Vacuum Dispersall Mixer.
2—Day Imperial 150 gal. jktd. double arm.
2—Baker Perkins 150 and 100 gal. jacketed double arm Sigma blades.
1—Baker Perkins 50 gal. jacketed, double-arm.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
1—Day 1500# Powder Mixer 304 S.S.
1—Patterson 6' dia. Conical Blender 15 HP.
1—3' dia. Simpson Intensive Mixer.
1—2' dia. Simpson Intensive Mixer 304 S.S.
1—45" dia. Lancaster Mixer 7½ Hp motor.
1—Patterson Kelley 150 cu. ft. Twin Shell Blender.
1—Patterson 80 cu. ft. Conical Blender, 304 S.S.

MISCELLANEOUS

3—Kinney Vacuum Pumps, 1000 cfm, 10 microns, 15 HP.
2—Hardinge 5' x 22" steel lined conical Ball Mills.
3—Mikro Pulverizers, 1SH, 1SI and Bantam.
3—Abbe 2½" x 3' porcelain lined Pebble Mill XP motor.
1—Raymond 10" vert. Mill, 10 HP.
1—#18 Cumberland Rotary Cutter.
3—Swenson Walker Continuous Crystallizers, 24" x 30' sections.
1—#24 Rotex Sifter, 20" x 64", Quadruple deck.
4—Stokes Rotary Tablet Machines DD2, DDS2, RD4 and RB2.
5—Day Roball Sifters, 40" x 120", 40" x 84", Double Deck.
3—Nash H6 Vacuum Pumps.
4—Stokes Rotary Tablet Machines DD2-DDS2-DS3-RB2.

Partial List of Values—Send for Complete Details

BRILL EQUIPMENT COMPANY

35-61 JABEZ ST., NEWARK 5, N. J. Tel: MArket 3-7420—N. Y. Tel: RE 2-0820
TEXAS OFFICE: 4101 San Jacinto St., Houston 4, Texas—Tel: JAckson 6-1351

CIRCLE C ON READER SERVICE CARD

2 CHEMICAL PLANT SALES

Niagara Falls, N. Y.; Everett, Mass.

STAINLESS COLUMNS

78"x18'x1¼" Vulcan 318 S.S. Bubblecap, 14 trays, 180 caps/tray, 50 PSI.
72"x30'x1⅛" Budd 347 SS Bubblecap, 21 trays, 38 caps/tray.
48"x41'x5/16" Vulcan 316 SS Bubblecap, 40 trays, 70 caps/tray, 100 PSI.
36"x21'x1¼" 316 ELC SS Packed, 15 PSI.
36"x20'x3/16" 316 SS Packed, 100 PSI.
14"x17'6"x1⅛" 316 SS Packed.
12"x18'8"x3/16 347 SS Packed, 100 PSI.

COLUMNS

20"x27' GLASS LINED 50 PSI full vacuum.
16"x21' GLASS LINED Scrubber
16"x10' GLASS LINED 25 PSI full vacuum.
84"x25'x⅜" Steel 8 Bubblecap trays.
60"x68'x5/16" Steel 35 Bubblecap trays.
36"x58'x5/16" Steel 35 trays with Reboilers.

REACTORS

Pfaudler 500 gal. ELL Gl. Lined Jktd. Agit.
Dopp 1000 & 1700 gal. Ni-Resist Jktd. Agit.
Vulcan 1000 gal. Everdur Coiled, Agit.
Patterson 1000 gal. Steel Jacketed.
Buflovak 900 gal. Stainless Agit. Elec. Heat.
Patterson 500 gal. Steel Jktd. Agit. 2 HP XP.
Alloy Tanks 300 & 750 gal. SS Press. Stills.

STAINLESS HEAT EXCHANGERS

2320 Sq.ft. 33"x21'-1"x16ga.x16' Tubes.
1000 Sq.ft. 27"x168"-¾"x16ga.x14' Tubes.
890 Sq.ft. 22"x20'8"-⅝"x16ga.14' Tubes.
800 Sq.ft. 23"x17'10"-¾"x16ga.x16' Tubes.
615 Sq.ft. 22"x15'9"-⅝"x16ga.x10' Tubes.
420 Sq.ft. 18"x9'6"-¾"x18ga.x8' Tubes.
300 Sq.ft. 14"x19'6"-¾"x18ga.x12' Tubes.
235 Sq.ft. 16"x8'3"-⅝"x16ga.x7' Tubes.
188 Sq.ft. 11"x16'8"x⅝"x14ga.x12' Tubes.
146 Sq.ft. 11"x14'x⅝"x16ga.x9'6" Tubes.
68 Sq.ft. 8"x17'3"-¾"x16ga.x16' Tubes.

CENTRIFUGES—FILTERS

Sharples C-27 Super-D-Hydrator Stainless.
Sharples C-20 Super-D-Hydrator Stainless.
30" Susp. Centrifuge-Imperforate Stainless.
Sharples #6 Super Centrifuge SS Bowl.
5'3"x3' Oliver Precoat Rot. Vac. Filter SS.
4'x1' Bird Young Rot. Vac. Filter Stainless.
36"x24" Goslin Rot. Vac. Filter Stainless.
18"x28" Bird Continuous Stainless.
400 sq.ft. U.S. Auto-Jet Filter Monel Screens

COMPRESSORS—VACUUM PUMPS

Nash #9 Compressors 2150 CFM @ 16 PSI.
Worthington YO 1360CFM @ 35PSI; 150 HP.
Norwalk Hydrogen Comp 5 CFM 15000 PSI.
Nash #4 Vacuum Pump 650 CFM @ 15".

STAINLESS STEEL TANKS

11500 gal. 12'x15'x3/16 agitated.
4500 gal. 6'x25'x¼" dish/cone 25 PSI coil
4000 gal. 8'x12'x3/16" dished Coiled.
3500 gal. 8'x9'x5/16" dished heads.
1500 gal. 6'x6'9"x¼" dished heads.
1200 gal. 5'x8'x¼" Agitated.
750 gal. 4'6"x6'x¼" dished 42 PSI.
500 gal. 4'x5'x5/16" dished heads.
500 gal. 4'x5'6"x¼" flat Agitated.
(20) Tanks 50 to 400 gal. some agitated.

SPECIAL ITEMS

TRIPLEX PUMP—2¼x4 Stainless 2000 PSI.
CRYSTALLIZER Squire 40"x30" Agit. Jktd.
CRYSTALLIZER Buflovak 6' Vac. Jkt. Agit.
CRYSTALLIZER Swenson 24"x20' Jktd. SS
AIR DEHYDRATOR-Anders 8FA Automatic.
ABSORPTIVE DRYER-Kemp FE02-S.
SIFTERS 30"x96"; 40"x84"; 60"x84" SS
CONVERTER-St. Wells 10'x29' 10000 sq. ft.
FURNACE-St. Wells 1MM/BTU oil fired.
HEATER 150KW Hot Oil Hynes Elec. Co.
MIXER 300 gal. B.P. Stainless Sig. 18 DIM.
BLENDER Conical 6' Paterson 69CF 10 HP.
BLENDER Conical 12' 500CF SS clad.
EVAPORATOR-435 Sq. ft. Single Effect.
CENTRIFUGAL PUMPS-STAINLESS-1" to 3" 10 to 750 GPM 35 to 100' Head

Representatives on Premises
Write for Detailed Catalog

HEAT & POWER CO. INC.

60 E. 42nd St., N.Y. 17, N.Y. MU 7-5280
310 Thompson Bldg., Tulsa 3, Okla. LU 3-4890

CIRCLE D ON READER SERVICE CARD

IT COSTS LESS at M&E

1—Mill, Raymond 5047 4 Roller High Side with Separator

3—New Super-De-Hydrators, Sharples C-27, type BM. Never installed.

1—Mechanical Air Separator, Sturtevant 16'. Fine condition

2—Centrifuges, Western States 40" type 316 SS perf bask. 25 HP

1—Laminating Press, Sepore 34" x 38" hydr. 250 ton cap. 8 opening.

3—Pulverizers, Mikro Model 1-SH SS. 5 HP Motors. New units

1—Filter, Niagara horiz press leaf SS lvs. 500 sq ft. Auto door

1—Screen, Selectro 2' x 6' SS Enclosed.

MACHINERY AND EQUIPMENT CO., INC.
123 TOWNSEND ST. · SAN FRANCISCO 7, CALIFORNIA

CIRCLE E ON READER SERVICE CARD

NEW FILTER, stainless steel NIAGARA 48" dia. w/510 sq. ft.

NEW GRANULATOR #24, Stokes oscillating, S/S, also used 43A, S/S

NEW VOTATOR, S/S, lab. model, 4 speed FURNACE, electric, 5"X12"X30" muffle, 1600°C, Globar, w/50KVA transformer

MIKRO PULVERIZERS, 2 model 2TH w/ 10HP motors & vari-drive feeds

OVEN, Truck/Tray, 650° F. electric, 5'X6'6"X14', self-contained package unit.

LAWLER COMPANY
Durham Ave. Liberty 9-0245 Metuchen, N. J.

CIRCLE F ON READER SERVICE CARD

FOR SALE

P & H 1400 Diesel electric shovel 4 cu. yd. dipper, 32' boom with large amount of spare parts. $48,500.

Marion 111-M dragline 90' boom 4 cu. yd. excellent condition. All electric with air controls. Smooth type tracks 20' x 44" pads. Unit can be re-powered with Diesel engine. $48,500

Marion, Model 490-E electric shovel 2½ Amsco dipper, 29' boom, excellent condition. $14,500.

Marion, Model 4101 electric shovel. This machine in excellent condition. Complete overhaul 1958. 2½ cu. yd. dipper; 33' boom. $22,500.

42" Mammoth McCully crusher $25,000.

All listed equipmnet to be sold "As Is Where Is", subject to prior sale or disposition.

Write or Wire:

MATERIAL SERVICE
Division of General Dynamics Corp.
4226 S. Lawndale Ave., Lyons, Ill.
Attn.: Ben Margules, Equip. Sales
Lyons, Ill. phone: Hickory 7-9750
Chicago phone: Bishop 2-2410

CIRCLE J ON READER SERVICE CARD

OVER 5,000 MACHINES IN STOCK

FOR EVERY INDUSTRY AND PURPOSE

- Wrappers
- Packaging machines
- Cartoning machines
- Fillers
- Labelers
- Filter presses
- Roller mills
- Mixers
- Pulverizers
- Grinders
- Dryers
- Sifters
- Cappers
- Tablet machines

TELL US YOUR REQUIREMENTS

Complete Details And Our Special Low Bargain Prices Available On Request

UNION STANDARD EQUIPMENT CO.
318-322 Lafayette St., New York 12, N. Y.
Phone: Canal 6-5333-4-5-6

CIRCLE G ON READER SERVICE CARD

BEST VALUES

Evaporator: Buflovak dbl. eff. st.st. 845 sq. ft.
Evaporator: Buflovak dbl. eff. st.st. 608 sq. ft.
Evaporator: Mojonnier dbl. eff. st.st. 1250 sq. ft.
Evaporator: Buflovak sgl. eff. st.st. 67 sq. ft.
Evaporator: Swenson four eff. C.I. 5700 sq. ft.
Dryers: Double Drum, 42 x 90; 32 x 100 Buflovak.
Dryer: Double Drum, 42 x 120 American.
Dryer: Rotary Steam Tube, Louisville 6' x 25' (2).
Votator—Girdler, with 2—4" x 46" S.S. T316. chilling cylinders.
Centrifuges Tolhurst 40" and 26" Suspended, perf.
Centrifuges: Bird continuous, 18 x 28, S.S. T316.
Filter, Rotary Vacuum with pressure housing, Dorr Oliver 5'3" dia. x 4' face (2).
Tanks: 2300 (2)—1500 gal. Vertical St.St.
Tanks: 3000 (2)—1500—900 gal. vertical St.St. for vacuum, with coils.
Kettles: (2) 500 gal. agitated st.st.; with 15 P.S.I. steel jacket.

BEST EQUIPMENT COMPANY
1737 W. HOWARD ST. CHICAGO 26, ILL.
AMbassador 2-1452.

CIRCLE K ON READER SERVICE CARD

Screener 2 Deck S.S., also steel

S.S. Jacketed—Blender—Double Ribbon —240 cu. ft.—total

Reactors 500 gal—750 gal steel

Baker Perkins—100 gal—50 HP, S.S. 2 arm jacketed-vacuum hdr. tilt

Aluminum Evaporator Calandria type—never used—1300 sq ft. tube area

Hydraulic Pumps & motors.

MACHINECRAFT CORPORATION
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. MI 2-7634

CIRCLE H ON READER SERVICE CARD

JULY SPECIALS

Read SS Jktd. 6 qt. Lab Mixer, vac. cover 1½ hp
Simpson 24" Lab. SS Mix Muller, 1½ HP motor
Day 75 gal. sigma arm Mixer with 7½ hp motor
2 Fitz Mills Model D, 5 HP motors
Abbe 5'x6' Jktd. Ball Mill, chrome mang. steel
Stokes vac. 2 shelf dryer 40" x 42" with pump
Gruendler #3 Hammermill, Whirlbeater, 22"
Pfaudler 1500 gal. glass lined Tank, closed top
Ribbon Blenders, Steel & SS, all sizes, New & Used

WHAT HAVE YOU FOR SALE OR TRADE? YOU CAN BANK ON

EQUIPMENT CLEARING HOUSE, INC.
111 33 Street, Brooklyn 32, N. Y.
SOuth 8-4451—4452—8782

CIRCLE L ON READER SERVICE CARD

Day Hy—R Speed Mill 20 HP Expl. Pr.
Buffalo 32"x90" Double Drum Dryer.
Centrifugals: 12", 30", 40" & 48".
Centrifuges: Sharples #5 & #6 Stainless.
Dryers: Hersey 5'x26' Rotary, 316 Stainless.
Buffalo Vac. Drum Dryer, 24"x20".
Gehnrich Elec. Htd. Dryer 7'x3'x6'.
Despatch Ovens Elec. Heated & others.
3—Devine & Stokes Vac. Shelf Dryers.
Filters: #2 Sweetland 12 Stainless Leaves.
Oliver Rot. Vac. 3'x1'.
Hercules Leaf Filter 36" diam.
Filter Presses: 6" to 36" Iron & Wood.
Kettles, Tanks: S.S. Jack 20 to 1000 gal.
Dopp 350 gal. cast iron Jack. Vacuum.
Devine Impreg. Units 30" to 36" dia.
Mills: Raymond #00, 3 HP, & #0000.
Mikro Pulverizers #4, 2, 1, & Bantam.
Hammer Mills & Pulverizers 3 to 50 HP.
Taylor-Stiles 7½ HP, Cutter.
Rotary Cutters 1½ to 5 HP, & up.
Spr. Waldron Stainless spike crusher.
Pebble, Jar & Ball Mills, Lab. to 6' x 8'.
3 Roll, 9" x 32", 12" x 30", 16" x 40".
Lehman 4 Roll W.C. 12' x 36" Steel.
Colloid Mills 1½ H.P. & up.
Mixers: BP & Day 75, 100 & 150 gal.
Baker Perk. 15 HP. Masticator Mixer.
Change Can Mixers 8, 15, 40, 150 gal.
Sprout-Wald., 10,000# horiz. Spiral Mixer.
Day Jumbo 700 gal. horiz. mixer.
Spiral Mixers, 3000, 1000# etc.
Lancaster 6' dia. 25 HP. & #1, 3 HP.
Pumps: Stokes etc. Vac. 10 to 500 CFM.
Gould 75 HP. Centrifugal 250 PSI.
Sifters: Day, Robinson, Rotex type.
Tablet Machines: Stokes R, Colton 4½ T, single punch. Stokes RDI Rotary.
Hydr. Presses, Plastic & Rubber Machy.

Partial Listings. Write For Bulletins

STEIN EQUIPT. CO.
107-8th St., Brooklyn 15, N. Y. Sterling 8-1944

CIRCLE M ON READER SERVICE CARD

COMPRESSORS

No better values at any price

72 CFM 1500 PSI 6¼-3¾-1⅜x7 CP
138 CFM 100 PSI 7x7, Ing. ES, CP & Joy
258 CFM 500 PSI 9½x4¼x11 Ing. ES2 New
288 CFM 100 PSI 9x9 Ing. Worth, CP
311 CFM 1500 PSI 10½x7⅛-3⅛-13 IR-ES3
420 CFM 40 PSI 12x9 Gardner (Ethylene)
465 CFM 100 PSI 12x11-IR-ES CP.T. Worth HB
502 CFM 125 PSI 12x13 Worth HB
676 CFM 110 PSI 15-9¼x12 Ing. XRE
686 CFM 100 PSI 14x13 Ing. ES
805 CFM 125 CFM 17-10x12 CP ace
1050 CFM 60 PSI 13-13x12 IR-XRE
1852 CFM 110 PSI 23-14x14 Ing. XRE
300 HP GE Syn 3-60-440 (2) 1952
2200 CFM 100 PSI 26-15x28 Ch. Pn. ace 350-HP 3-6-4160-4600 .8 PF
2610 CFM 45 PSI 20-20x14 Ing XRE 250 HP Syn.

AMERICAN AIR COMPRESSOR CORP.
Chem. Road, North Bergen, N.J. UNion 5-1397

CIRCLE N ON READER SERVICE CARD

SPECIALS

Kettles: 69 Lee 40 gal. stain. clad, 40# WP,
Concentrator: Deister 5x8' rubber covered.
Column: 24" x 22', 316 stain. steel.
Pebble Mills: Abbe #3, #6, and others.
Dryer: American 24x48" dbl. drum.
Dryer: Bowen lab. spray, st. st.
Evaporator: Buflovak sgl. eff. st. st. 94 sq. ft.
Dryer: Porter 2 x 4' vac. drum., st. st.
Centrifugal: Tolhurst 26" rubber, 2-speed.
Filter: Sweetland #5 st. st. lined.
Filter: Eimco, drum 18" x 12".
Vacuum Pans: 42" and 72" stain. steel.
Dryer: Proctor & Schwartz 6-tray st. st.
Centrifugal: AT & M 60" st. st. perf.

Write us or call Seeley 8-1431
Send us a list of your idle machines

LOEB EQUIPMENT SUPPLY CO.
820 W Superior St., Chicago 22, Ill.

CIRCLE O ON READER SERVICE CARD

YOUR $ BUYS MORE

NEW STAINLESS EVAPORATOR

Long tube 751-1" OD 12 ga tubes 15' long. Evaporation rate 17,000# water per hour at 235° F. Entire unit constructed of type 309 and 304 stainless steel.

Immediately Available From Stock

ME MACHINERY AND EQUIPMENT CO., INC.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE P ON READER SERVICE CARD

EQUIPMENT READY FOR IMMEDIATE SHIPMENT

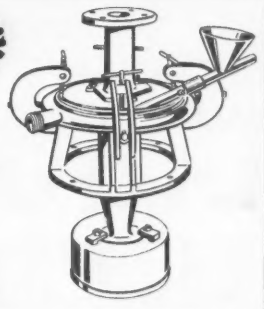
SPOTLIGHT SPECIALS

Extruders by Royle, NRM, Welding Engrs. and others all sizes and types NOW. Banbury Mixers, #00, #11.

FMC

SAVE $6,500.

on this 30" Sturtevant MICRONIZER Stainless Steel



Just Purchased a Battery of J.H. Day Cincinnatus Double Arm Jacketed Mixers; 300 Gal., 200 Gal. and 75 Gal. with or without Motors.

CENTRIFUGES

Stainless Centrifugals from 30" to 60"; A.T.&M. Tolhurst, Fletcher, etc.
Tolhurst 40" Suspended Centrifuges; Rubber Covered Perf. Baskets and Curbs; Monel Plow-Discharge.
2 Sharples Stainless Steel Model PN14 Super-D-Canters.
4311 S 1 Sharples C 27 Super-D-Hydrator in Type 316 Stainless with 40 HP
5147 S 13-14 Two Bird Continuous Screen Type Horizontal Centrifuges; Monel & S.S.; 24" x 24".
2 Bird Rubber Covered, 48" with Plows; Fume Tight; 40 HP.

REACTORS—PRESSURE VESSELS

2 Stainless 400 gal. Reactors Jktd. Agtd. by Patterson and Struthers.
6 Dorr-Oliver Stainless Steel Thickeners or Reaction Vessels; 550 gal. 5' x 5'.
Stainless Reactor, 2000 gal. Fully Jktd. Agitated.
Nickel Clad Reactor, 7' x 11'6".
Lancaster Stainless Lined Rotary Reactor or Digester; 50" x 17'4"; Jacketed; good for 300 PSI Internal.
Pfaudler Gl. Lined Reactors; all sizes from 50 to 500 gal.
Mojonnier Stainless Vac. Pans; 3' x 10' and 6' x 12'; others.
Farrell-Birmingham Unused 2 Roll Mills 14" x 30"; late type; with Uni-Drives at a fraction of the new price.

FILTERS—FILTER PRESSES

4 Pressure Filters 30" x 56" Type 316 Stainless; 100 sq. ft.
Plate and Frame Filter Presses, 7" to 42" in Stainless, Cast Iron, Ni-Resist, Aluminum, Nickel, Bronze, etc.
S/S Nutsche Type Filter; 6' x 2'.
Bowser Filter with Pump; 2000 GPH.

OLIVER PRECOAT FILTERS

3" x 2" Monel. 5'3" x 8' Stainless.
(2) 5'3" x 3" Steel or Rubber.
Feinc S/S Rot. Vac. Filter 3' x 1'.
Oliver Cont. Rot. Vacuum Filters. Panel Type; 8' x 8' and 8' x 10'.

DRYERS

Link Belt Roto Louvre Dryer Model 502-20.
Double Drum Dryers to 40" x 120".
Devine Double Door Vacuum Chamber Dryers; Model No. 36.

MILLS—PULVERIZERS

2 Stainless Steel Micronizers 30".
Abbe, Ball & Jewell Rotary Cutters; in a wide range of sizes, capacities.
Ball Mills and Pebble Mills by Abbe, Paterson, International, some Jacketed; up to 8' x 8'.
Mikro Pulverizers up to No. 4's.
Fitzpatrick Comminutators; Models M, K and C; motorized.
American Ring Roll Crusher; 50 HP.
Mikro S/S Atomizers; Nos. 6 and 5.
Raymond Imp Mills; many sizes.
Williams Hammer Mills to 60 HP.

MIXERS ALL TYPES

Baker Perkins Jktd. 5 gal. UNE-7, Dbl. Arm Mixer with pressure cover.
BLAW-KNOX 600 cu. ft. Conical Blender; 9'6" Dia.
Baker Perkins Jktd. Mixers, 50 gal., 100 gal., 150 gal., 200 and 300 gal.
NOW IN STOCK for IMMEDIATE DELIVERY. ALL SIZES FALCON Ribbon Blenders in Steel or Stainless.

CONTINUOUS FINE GRINDING EQUIPMENT

To be Sold Direct from Location
2 Allis Chalmers 7' x 22' (2 Compartment) Compeb Mills, Meehanite Liners; 400 HP
1 Allis Chalmers 9½ x 810 Preliminator or Continuous Ball Mill; Meehanite Liner magnetic-coupled to 400 HP Motor
3 Allis Chalmers 7' x 22' Continuous Ball Tube Mills, Meehanite Liners, each driven by a magnetic coupled 400 H.P. Motor now operating in closed circuit with
3 Raymond 14 Ft. Double Whizzer Mechanical Air Separators, each driven by 75 HP Motor. New in 1950

FIRST MACHINERY CORP.

209-289 TENTH STREET, BROOKLYN 15, N. Y.

FMC Pays MORE For Your Surplus

PARKING ON THE PREMISES
Phone: STerling 8-4672
Cable Address: "EFFEMCY"

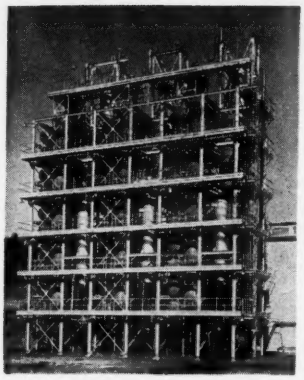
FMC

CIRCLE Q ON READER SERVICE CARD

AN ANNOUNCEMENT OF TREMENDOUS IMPORTANCE TO THE CHEMICAL-PROCESS INDUSTRIES

MULTI-MILLION DOLLAR LIQUIDATION

NORTH LITTLE ROCK, ARK.



STAINLESS STEEL TANKS

6—13,300 gal., 11'10"x15'7", cone top.
3—12,000 gal., 11'6" x 15'6", cone top.
18—3650 gal., 10' x 7', open top.
3—3000 gal., 5' x 19', T347SS, ASME 60 psi, dished heads.
60—1350 gal., 4' x 14', T347SS, ASME 60 psi, dished heads, int. coils.
9—1300 gal., 7' x 4'6", T321SS, closed
3—1100 gal., 4' x 11', T347SS, ASME 60 psi, 3/16" shell, ¼" heads.
27—476 gal., 4'6"x4', open top.
54—475 gal., 5'6"x2'6", open top.
27—445 gal., 6'x2', open top.
3—300 gal., 4'x3', T347SS, ASME 60 psi, dished heads.
9—285 gal., 41"x49", open top.
9—260 gal., 40"x48", closed top.

GLASS-LINED TANKS

18—Pfaudler 11,500 gal. horiz. blue glass-lined tanks, 8' x 30', ½" shell, 7/16" dished heads, 20 psi. With 75 sq. ft. nickel coil, Aurora St. St. sump pump.

STEEL PRESSURE TANKS

9—28,000 gal. 11' x 38', dished, ASME 75 psi.
11—28,000 gal. 11' x 38', lead-lined.
2—14,000 gal., 8' x 36', dished.
2—11,000 gal., 8' x 27', dished, ASME 300 psi.
5—9000 gal., 8' x 23', dished.
54—5200 gal., 6' x 24', dished, 60 psi.
3—3300 gal., 6' x 15-6", dished, ASME 125 psi.

ACID EQUIPMENT

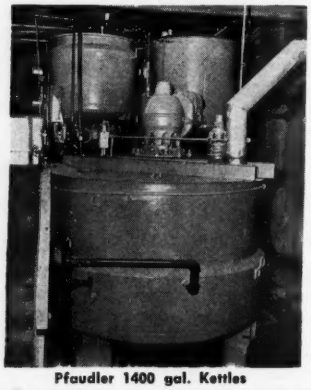
4—Cottrell carbon-tube electric-mist precipitators, (88)-tubes, lead-lined shell.
8—Graver concentrating drums, 10' dia. x 23' long, lead-lined, with furnaces.
8—5500 gal. gas-cooling tanks, lead-lined.
25—Acid-cooling tanks, lead-lined.
16—Duriron denitrating concentrators, 24" dia.x15' high, packed w/Amorphous Quartz.
4—Duriron 24" dia. x 4' high vac. denitrators.

FILTER-TANKS

54—24 sq. ft. Pfaudler 475 gal. St. St. filter tanks, 66" x 30", filter plate.
27—28 sq. ft. Pfaudler St. St. filter tanks.

KETTLES—REACTORS

72—1400 gal. Pfaudler blue glass-lined jacketed kettles, 84" dia. x 54" high, open top, Stainless Steel cover, 3 HP Agit., Adj. baffle.
18—1250 gal. Pfaudler blue glass-lined jkt. reactors (Sulphonators), 72" dia. x 72" high, closed, 3 HP Agit.
54—600 gal. Pfaudler Stainless Steel ammoniating & crystallizing jkt. kettles, 60" dia. x 46" high, open top, Fume hood.
72—250 gal. Pfaudler blue glass-lined jacketed kettles, 42" dia. x 36" high, open top, Stainless Steel cover.



Pfaudler 1400 gal. Kettles

COLUMNS—HEAT EXCHANGERS

16—24" dia. x 15' high Duriron packed columns.
1—24" dia. x 33' high Duriron & St. St. packed column.
4—24" dia. x 4' high Duriron vacuum denitrating columns.
6—1450 sq. ft. T347SS gas condensers, 3-pass Vert. units, inner & outer tubes.
3—1000 sq. ft. Duriron cascade-type pipe coolers.
3—564 sq. ft. Stainless Steel burner-Preheaters, gas condensers, 3-pass.
2—435 sq. ft. Amer. spiral steel exchangers.
9—400 sq. ft. Stainless Steel open-pipe coolers, 2⅜" OD pipe.
12—Amer. spiral heat exchangers T316L S/S: 162, 72 sq. ft.
48—Duriron pipe coolers, 159, 130, 125, 99, 54, 44, 42, 10 sq. ft.
3—18 sq. ft. Ammonia evaporators.

COMPRESSORS—BLOWERS

3—Worthington 3500 CFM air comp., 24 x 15, type LTC-4, 500 HP gas driven.
1—Chicago-Pneu. 3026 CFM air comp., size #19-32-30-18 x 24, horiz. steam driven.
8—Elliott turbo-blowers, 11,620 CFM, type 0, 15.9 psi discharge, 125 HP.
18—Ing.-Rand 6 x 6 x 5 air comp., V-type, 2 cyl, #67D9, type 30, 10 HP.
3—Frick 4 x 4 Ammonia comp., type HB.
2—Worthington 5½ x 3⅛ x 3½ air comp., V-type, 7½ HP.

CENTRIFUGAL PUMPS

20—Worthington 3" x 2", Worthite, #2CG2B, 75 GPM @ 139' 15 HP.
18—Worthington 2" x 1½", Worthite, #1½CG1A, 5 HP.
81—Worthington 2" x 1½", Worthite, #1½CG1A, 3 HP.
30—Worthington 2" x 1½", Worthite, #1½CG1.
27—LaBour 2" x 1½", T316SS, size #15, type DPI, self-priming, 3 HP.
3—Worthington 1½" x 1", Worthite.
8—Ing.-Rand 10" x 8", Iron, size #8AFV, 1800 GPM.
50—Misc. Iron cent. & gear pumps.

BOILERS

3—3000 CFM Edgemoor waste-heat boilers, 250 psi, 535 sq. ft., ASME.
5—435 HP Comb. Eng. water-tube boilers, 300 psi, 4620 sq. ft., 34,500 lb. steam/hr. @ 225% of rating, gas or oil fired.

MISCELLANEOUS

3—Alloy Fab. gas mixer-filters, (3) compartments, Stainless Steel contact parts.
30,000'—Stainless Steel pipe; 6", 4", 3", 2", 1½", etc.
10,000'—Stainless Steel vapor pipe; 12", 16", etc.
10,000—Valves, Stainless Steel, all sizes.
18—Screens, Stainless, 33"x53", single deck.
18—Toledo platform dial scales, 200#.

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Drycolene Producer, G. E., 2000° 200 cu. ft. Type G2
Screen Vibrator, J. H. Day, 50" x 116"
Wood Crusher, WILLIAMS HF, 30 HP Swinging Hammer Type
Turnings Crusher, #2400 AMERICAN, Requires 50-60 HP, 2½-2½ tons per hr.
Hammermill, DIXIE, swinging knives, Requires 25-30 HP
Tablet Machine, New RD3X STOKES, 7 ton 13/16" die.
Tablet Machine #1035 COLSON, 35 station, 1" die
Calandria Pan, with vacuum pump, 11'8" diameter, 13' high
Stainless Tank, 42" dia. x 60" high, 10 ga., bottom discharge
Tanks—Vertical & Horizontal, 7500-8000 gallon
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Dust Collectors, AMERICAN Rotoclone, 5250 CF
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#47B BUCYRUS 25 ton, 50' boom
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CLEAVER BROOKS Package, 30 HP, 30# press., oil fired (2)
#22 JOHNSON 250 HP, 125#, oil, new 1953

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DINGS Magnetic, 20" x 15" drums—NEW
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RAYMOND Single Whizzer Type, Mechanical, Air, 4" dia. feed
#C1824 STEARNS Portable Magnetic, 12" x 20" drums, 2 HP

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2—French Oil type 2-S screw-type extraction presses 300 PSI, 60 HP.
5—Shriver 48" Cast Iron P. & F. filter presses, (50) chambers
2—19,900 sq. ft. quadruple effect calandria type evaporators
6—691 sq. ft. dbl. pipe coolers
3—American 654 sq. ft. spiral steel heat exchangers
18—Tubular heat exchangers, copper tubes: 1500, 1350, 1130, 637, 380, 290, 184, 176, 156 sq. ft.
2—9500 gal. horiz. cookers, 9' dia. x 20' long, ½" shell & heads.
2—Warren 12" x 12" cent. pumps
250—Steel cenrtifugal pumps, 1" to 12", 1 HP to 150 HP
2—Aldrich triplex pumps, 175# WP.
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PLANT EQUIPMENT
4' Traylor TY Gyratory Crusher
2—Wemco 2M-HMS Plants
No. 1 Stirtevant Rotary Fine Reduction Crusher
F55 Syntron Grizzley Feeder
5' x 8' & 4½' x 9' KVS Air Swept Ball Type Mills
Ball Mills: No. 56, 5' x 5', 6' x 4', 6' x 9' & 7' x 22'
Hardinge Mills: 3 x 8', 3' x 24" & 5' x 22"
Rod Mills: 4' x 11', 6' x 12' & 7' x 15'
Jaw Crushers: 8" x 10", 9" x 24", 10" x 30", 12" x 26", 13" x 24", 14" x 28", 18" x 36", 30" x 36", 48" x 60", 66" x 84"
Crushers, Fine Reduction: 22", 2', 3', 4', 5½' & 7'
436 Allis Chal Hydrocone 75 H.P. Motor
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Mixers: Stokes 60 cu. ft. vac. dryer/mixer, Mod. 59-B; J. H. Day 1,000# black iron; Baker Perkins 300 gal., size NIM; Gredge & Gray 4,000#.
Reactors: All Pfaudler ASME coded & glass lined, all jacketed and agitated: 500 Gal. Type R; 300 Gal. Type R; 100 Gal. Type ES.
Tablet Presses: Stokes Rotary Model DDS-2; Colton Mod. 3 RP and 4½ T; Kux Hi speed Mod. 25.
Tanks: Perry 100 gal. W/¼ HP mtr; haveg 250 to 1,000 gal.; Alum. bottom, 300 gal.; Steel jacketed 550 & 750 gal.; Stainless 1000 & 2000 gal.; S/S lined 2300 & 6500; glass lined 575, 890, 933 & 1,315 gal. Wooden 1060 gal. W/stainless coil.

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1—Gemco SS jacketed rotary vacuum blender, 92 cu. ft.
5—Western States type 316 SS 40" suspended type centrifuge complete with perforate baskets, plows and motors

AUTOCLAVES, KETTLES, REACTORS

1—2000 gal. stainless steel jacketed reactor
1—Patterson-Kelley 1000 gal. stainless steel jacketed reactor
1—Pfaudler 750 gal. glass lined jacketed reactor
2—Pfaudler Series EM 300 gal. glass lined jacketed reactors
1—300 gal. Hastelloy "B" jacketed pressure reactor
2—Theo. Walters, Hastelloy "B" 300 gal. jacketed reactors
1—Blaw Knox 300 gal. stainless steel vacuum reactor
4—Pfaudler Series P glass lined jacketed reactors, complete with agitators and drives, 5, 20 and 30 gal.
2—Blaw Knox steel autoclaves, 600 gals.
1—Alloy Fabricators steel jacketed autoclave, 600 gals.
1—125 gal. S.S. jacketed autoclave with impeller type agitator and drive, 125 psi jacket, 75 psi internal
1—Van Alst 300 gal. stainless steel jacketed kettle
1—10,000 gal. horizontal rubber lined storage tank

DRYERS

1—Allis Chalmers stainless steel rotary dryer, 6' x 50'
10—Allis Chalmers rotary dryers, 6' x 50' and 7' x 60'
1—Buflovak SS jacketed rotary vacuum dryer, 5' x 30'
1—Link Belt steel roto louver dryer, Model 207-10
1—Link Belt steel roto louver dryer, Model 502-20
2—Stokes SS jacketed rotary vacuum dryers, 3' x 15' and 2' x 6'
1—American 42" x 120" double drum dryer, ASME, complete
1—Buflovak steel jacketed rotary dryer, 3' x 15'
2—Stainless steel pilot plant spray dryers

CENTRIFUGES

1—AT&M 48" SS suspended type centrifuge, complete
1—Fletcher 48" SS underdriven centrifuge, complete
1—AT&M 26" type 316 SS suspended type centrifuge, complete
5—Tolhurst 40" and 30" rubber covered centrifuges
1—Sharples type 316 SS Super-D-Canter, PN-14, complete
1—Sharples type 316 SS centrifuge, Model D-2
1—Sharples Model C-27 Super-D-Hydrator

FILTERS

2—Oliver SS rotary filters, 3' x 2' and 3' x 4'
1—Hercules SS filter with 6 leaves

THE GELB GIRL—JULY 1961

12—Sweetland #12 pressure leaf filters with 72 SS leaves
1—Niagara stainless steel filter, Model 510-28
1—Sperry 36" x 36" heresite covered filter press, 40 chambers
10—Shriver plate and frame filter presses, 12" to 42"

MIXERS

1—Stokes stainless steel granulator, Model 43B
1—Sturtevant #7 Dustite rotary batch blender, NEW
15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Robinson type 304 SS horizontal blender, 125 cu. ft.
1—Baker Perkins 150 gal. dispersion mixer, complete
1—J. H. Day 5-gal. double arm sigma blade mixer, SS
1—Stokes stainless steel granulating mixer, Model 21-J
1—Patterson-Kelley SS twin shell blender 2 cu. ft.

MISCELLANEOUS

1—Cleaver Brooks 500 HP package steam generator, 200#
1—Cleaver Brooks 150 HP package steam generator, 150 psi
1—Superior 300 HP package steam generator, 125 psi
1—Sprout Waldron pelletizer, Type 501FF
1—Williams "Comet" 4 roll mill, complete
1—Raymond 2 roll high side mill
1—6" x 14" Ross 3 roll paint mill, high speed, complete
1—Vulcan SS bubble cap column, 4' dia. x 25 plates
1—Griscom Russell SS heat exchanger, 900 sq. ft.
1—Downington SS heat exchanger, 750 sq. ft.
3—Badger SS heat exchangers, 500 sq. ft. and 600 sq. ft.
4—Patterson SS condensers, 200 and 300 sq. ft.
20—Davis Engineering SS heat exchangers, 102, 119, 136, 166 sq. ft. NEW
2—Davis Engineering Carpenter 20 heat exchangers, 120 sq. ft.
2—Mikro Bantam pulverizers
2—Mikro #3TH SS pulverizers, complete
3—Pfaudler glass lined thimble type condensers, 9 and 14 sq ft.
1—Struthers Wells SS 1150 sq. ft. single effect evaporator

2—Process Equipment 10,000 gal. vertical stainless steel storage tanks
2—Louisville 8' x 50' SS rotary dryers
1—Stokes double drum dryer, 5' x 12'
1—Pfaudler 30 gal. glass lined jacketed reactors.

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